

ILYA NOVIK

**SOCIETY
AND
NATURE**

**SOCIO ECOLOGICAL
PROBLEMS**

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ОБЩЕСТВО И ПРИРОДА
Социально-экологические проблемы

На английском языке

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FOREWORD

There has been a marked deterioration of the environment on our planet in recent years, and so the problem of society's interaction with nature has become increasingly acute and taken a global character.

The importance of efforts to protect it under developed socialism was stressed at the 26th Congress of the CPSU. The guidelines to the USSR's economic and social development in the 11th five year-plan period contain a special section on the tasks of maintaining and improving the habitat. In particular this section speaks of the need 'to step up work on setting up and perfecting the system of natural resources cadastral and on improving the state control over nature utilization and protection of the environment'.¹

Everyone now recognises that urgent measures of a social, political, economic, legal, scientific, and technical nature are needed to overcome the unfavourable ecological situation. It is also most important when dealing with socio-ecological problems to think them out in the philosophical methodological sense. A flood of literature on these problems is pouring out in all

¹ Guidelines for the Economic and Social Development of the USSR for 1981-1985 and for the Period Ending in 1990 in *Moscow News Supplement* to issue N° 49 (2933), 1980, p. 9

countries today. Two extremes are common in it, one a conception of ecological pessimism that considers death of the human habitat inevitable because of scientific and technical development, and the other a conception of technical superoptimism that assumes it possible to cope with all the ecological difficulties of modern times simply by means of technique and the natural sciences

Prof. Novik points out the unsoundness of both these extremes. It is hoped that the reader will be interested to make a deeper acquaintance with a philosophical and methodological survey of these problems from the standpoint of dialectical materialism and the historical optimism inherent in the Marxist-Leninist theory of social progress.

Fuller acquaintance with the angle on the socio-ecological aspects of contemporary scientific and technical development given here by a Marxist philosopher will, it is hoped, foster scientists' co-operation to study the problems of exploiting nature. Since nature protection is a global problem in our day, it needs a strengthening of the spirit of detente and confidence among nations to solve it, which would help us to co-operate more effectively and comprehensively to find the optimum relationship between social and natural scientists of various trends.

Prof. Ilya Novik is a Soviet philosopher and specialist in the field of the methodology of science, well known to fellow-specialists in many countries. In recent years two major group works on socio-ecological problems have been published in the Soviet Union under his editorship, and

contributions by him: *Methodological Aspects of Studying the Biosphere* (1975) and *of Optimisation in Ecology* (1978).

In *Society and Nature* Prof. Novik describes the instructive experience of the socialist utilisation of nature, at the same time critically analysing the reasons for disturbance of the environment in other social conditions. He demonstrates that under capitalism ecological stress is not some chance error, insidious blunder, or fatal misapprehension. The conflict of society and nature under that system stems naturally from the worker's separation from the instruments of production, which do not belong to him. In bringing out this feature of capitalism Marx wrote that it is characteristic of capitalism that

it is not the unity of living and active humanity with the natural, inorganic conditions of their metabolic exchange with nature, and hence their appropriation of nature, which requires explanation or is the result of a historic process, but rather the separation between these inorganic conditions of human existence and this active existence, a separation which is completely posited only in the relation of wage labour and capital¹.

Society and Nature shows that the real unity of nature and society (Prof. Novik calls this state the monistic aspect of man's relation with the environment) is ultimately realised precisely through collective ownership of the instruments and means of production.

It is stressed, at the same time, that it does not follow at all from this fact that it is impossible or illegitimate for different socio-economic systems to co-operate and interact in the sphere

¹ Karl Marx, *Grundrisse. Introduction to the Critique of Political Economy* Translated by Martin Nicolaus (Penguin Books, Harmondsworth, 1973), p. 489

of maintaining an ecological balance throughout the world. On the contrary, the book shows that various forms of interaction are being implemented on three main levels—inter-governmental, regional, and global—both in the field of scientific research and in the sphere of concrete nature conservancy measures.

Methodological aspects of the problem of society's relation with nature during the present scientific and industrial revolution occupy a central place in *Society and Nature*. In substantiating the monistic unity of man and nature, Prof. Novik notes, basing himself of the principles of materialist dialectics, concretised in regard to socio-ecological problematics, that neither society's development nor nature's evolution can be annulled, because they are both governed by the objective laws of reality. But at each historical stage these two forms of objective development may be related to each other in a different way.

The controllable quality of the environment under a planned socialist society is thus organically united with a consciously planned way of life of individuals and with rational development of their needs and wants.

For forecasts in this field the following remark of Marx and Engels' is of fundamental importance:

The different forms of material life are, of course, in every case dependent on the needs which are already developed, and the production, as well as the satisfaction, of these needs is an historical process¹

¹ Karl Marx and Frederick Engels *The German Ideology* *Collected Works*, Vol. 5 (Progress Publishers, Moscow, 1976), p. 82.

In fact the future state of the habitat depends essentially on the aims and scale of values that we form now in the field of consumption.

The synthesis of the sciences, which much of Prof. Novik's book is devoted to analysing, is exceptionally important on the plane of resolving these problems. In that respect he bases himself on the following fundamental thesis.

Fresh opportunities for fruitful theoretical, fundamental, and applied research arise in inter-disciplinary areas, notably in the natural and social sciences. These should be fully used.

Prof. Novik demonstrates throughout his exposition that attempts to examine alarming trends in the present-day development of the biosphere, especially ones employing computer modelling of the processes of global development, have a complex systems character, and speaks of the illegitimacy of highly specialised scientists' distrust of a systems analysis of socio-ecological problems carried out on a multidiscipline basis. The arguments he adduces convincingly demonstrate the productive character of integrating knowledge in a systems modelling of the interaction of society and nature.

It is to be hoped that Prof. Novik's comprehensive study of the methodology of tackling modern ecological problems will be useful to readers in English-speaking countries who are concerned with and about the acute problems of conserving man's habitat.

*I. V. Bestuzhev-Lada,
Dr. Sc. (Hist.)*

We, with flesh, blood, and brain, belong to nature, and exist in its midst

Frederick Engels.¹

INTRODUCTION

The problem of man's interaction with his environment has always been of considerable practical and theoretical interest, but now, in the age of the scientific and industrial revolution, it has become particularly acute. The negative aspects of the present-day ecological situation that have come to light call for elucidation of their scientific, and philosophical meaning.

In order to realize the intricate tasks of preserving the habitat with any success, the fight for peace and the security of nations is of decisive importance. In his report to the 26th Congress of the CPSU Leonid Brezhnev emphasised:

By safeguarding peace we are working not only for people who are living today, and not only for our children and grandchildren: we are working for the happiness of dozens of future generations

¹ Frederick Engels *Dialectics of Nature*. Translated and edited by Clemens Dutt, with a Preface and Notes by Prof. J. B. S. Haldane. F. R. S. (Lawrence & Wishart, London, 1940), p. 292.

If there is peace, the creative energy of the peoples backed by the achievement of science and technology is certain to solve the problems that are now troubling people.¹

Defence of the natural environment is without doubt one of the most acute problems of modern times, which can be tackled in an all-round way only given peace, detente, and arms cuts.

In this book we shall concentrate on the methodological principles of the approach to today's ecological situation, and on the problems of an optimum combination of the future development of technology with the conservation and development of nature, and finally on clarifying the combined scientific (natural and social) character of ecological problems.

Much attention was devoted to socio-ecological problematics at the 16th International Congress of Philosophy held in August and September, 1978, in West Germany. Some papers from capitalist countries reduced it to the uncontrollable character of scientific and industrial development and the socio-ecological consequences of that. The paper of the West German philosopher Karl Becker, in particular, was built on that plane.

The plenary paper of D M Grishman, Member of the USSR Academy of Sciences, 'Control of Scientific and Technical Progress', was opposed to that point of view. It substantiated the possibility of planned development of science and technology. By carrying out such planned development on the basis of collective ownership it is

¹ L. I. Brezhnev *Report of the Central Committee of the CPSU to the XXVI Congress of the Communist Party of the Soviet Union and the Immediate Tasks of the Party in Home and Foreign Policy*, Novosti Press Agency Publishing House, Moscow, 1981, pp. 53-54.

In the global model developed by Mesarović and Pestel they undoubtedly approach the problems of the interaction of society and nature in a more differentiated way than the authors of the limits-of-growth model. Their ten regions are demarcated according to level of industrial development, degree of pollution of the environment, standard of provision of food, and so on. But the main methodological omission cannot be glossed over by introducing a theory of the interaction of sub-systems, since it is connected with their ignoring of the difference in principle between capitalist and socialist countries' attitude to the environment. Mesarović and Pestel appeal to an abstract theory of organic growth without mentioning the real fact that co-ordinated growth of such a kind is only fully realised on the basis of a socialist economy with a national plan.

They are unable to allow for the effect of the objective law of the uneven development of capitalist countries in the epoch of imperialism discovered by Lenin. Because of that the reasonable considerations in their research (for example, on the need to aid developing countries) have a utopian tinge.

Some Western authors, when analysing the relationship between scientific and technical progress and nature conservancy are led to criticise many aspects of the capitalist social system. Thus the American ecologist Barry Commoner has in fact pointed out the lack of perspective of systems of utilising nature that are subordinated to capitalist profit. An English reviewer wrote of Commoner's *The Poverty of Power* that he

had written what amounts to a socialist critique of modern capitalism, basing his analysis on the energy crisis which faces the Western world. This he sees as the

long-awaited crisis of capitalism, predicted by Marx' ¹

In its rational conception such an analysis could provide the constructive theoretical basis for collaboration of the scientists of capitalist and socialist countries in the field of developing ecological models on a regional and a global scale.

For modern science is based on the axiom that man's relationship with nature can be optimised at any given historical stage, can be given the best form for the given conditions. This axiom in turn serves as the basis for a general theory of the progressive development of nature, society, and thought. The fundamental principles of the optimisation of socialist nature-use were formulated by the 26th Congress of the Communist Party of the Soviet Union, which stressed that concern for the defence of nature was an integral element of national planning under socialism.

The Congress outlined that a sum of \$1,000 million roubles was to be spent on conservation in the USSR under the Tenth Five-Year Plan (1976-1980), and more would be spent in the future. It then formulated an important methodological principle of socialist nature use.

In view of the rapid rate of growth of the economic potential and the people's living standard, the funds for environmental protection can only be obtained by raising production efficiency.²

¹ David Elliott, Review of Barry Commoner *The Poverty of Power* (Jonathan Cape, London, 1977) in *Labour Monthly*, 1977, 59, 9: 430.

² L I Brezhnev, Report of the Central Committee of the CPSU to the XXVI Congress of the Communist Party of the Soviet Union and the Immediate Tasks of the Party in Home and Foreign Policy, p. 52.

Such a raising of industry's efficiency was built into the Tenth Five-Year Plan under which the growth of industrial production was to be much greater than growth of the extraction of such decisive natural resources as coal and oil.

We can infer therefore that not only is intensive growth of production not an alternative to conservation of the natural environment under socialism but on the contrary that intensification of production is a *sine qua non* of conservation of the biosphere. It has come to be that economy of resources—nature conservation—growth of production (quantitatively and qualitatively) are the elements of a single socio-ecological system. They constitute a dialectical trinity expressing the essence of the so-called global problems characteristic of our time.

What, in essence, are these 'global' problems? They are those that refer to the development of human life on our planet as a whole. And they include, above all, the establishment of lasting peace, equitable international relations, the problem of ensuring natural resources in the future, both renewable (air and fresh water) and non-renewable (primarily energy raw materials), and of providing every inhabitant of our planet with the requisite amount of food, the problems of conserving the environment, and the problems of the health and reproduction of the population.

These issues are new in a certain sense not only on the social plane but also methodologically, and their most important logical-philosophical feature is linked with their complex systems character. Their solution is therefore a serious, difficult assignment for a whole group of natural and social sciences. At the same time the very posing of these supercomplex problems

*Yet nature is made better by no mean,
But nature makes that mean: so, over
that art.
Which you say adds to nature, is an art
That nature makes . . .
The art itself is nature*

(Act IV, Scene 4)

Rationally humanised nature does not disturb the biosphere harmonised in relation to man

'In practice,' Marx wrote, 'I can relate myself to a thing humanly only if the thing relates itself humanly to the human being '¹

The 'society/nature' relationship is closely linked with that basic problem of philosophy, viz. that of the relation of the acting and cognising subject to the object existing outside his consciousness. The natural object counterposed to man's metaphysical constructs as a force alien and hostile to him figures in the materialist humanist world outlook as an integral component of the system of human being at all stages of its development. Modern man, possessing stupendous power, cannot exist without the natural conditions he needs any more than primitive man could, who depended on nature and was subordinated to her. The character of the interdependence of man and nature itself has, of course, altered qualitatively. In the early stages of history man was relatively weak in the face of powerful nature but now, in the age of the scientific and industrial revolution his technical power, unco-ordinated in its consequences, can cause

¹ Karl Marx Economic and Philosophic Manuscripts of 1844. In: Karl Marx and Frederick Engels, *Collected Works*, Vol. 3 (Progress Publishers, Moscow, 1975), p. 300.

nature's possibilities is turned into a kind of weakness. Urgent rational measures harmonizing the inter relations of technique and nature are really necessary in this field. After all, many of the adverse effects that have now acquired alarming proportions had already been noted in their initial forms in the last century. The British journal *Fisheries Herald*, for example, printed an article in its twelfth issue of 1871 that discussed the global effect on fish of the oil getting into water reservoirs, and measures to combat it.

Scientific and technical progress, by creating new substances, has not at the same time released industry from its connection with natural resources. It requires a much greater outlay of natural resources to make the materials born of the technical progress of recent decades than is needed for traditional ones. It takes from six to thirty cubic metres of water, for example, to make a tonne of cotton cloth, but 5,000 cubic metres to make a tonne of capron.

The problem of conserving the USSR's water resources calls recently for special attention. During the quinquennium 1976-80, all Soviet industries were to go over to using recycled water.

In principle technique and technology can not only greatly reduce the degree of disturbance of the hydrosphere but also improve the quality of water (experiments in fluoridising waters entering urban water mains, for example, so as to improve the quality of urban residents' teeth are of interest in this respect).

Even 'wild' nature can be improved, in principle, by technical progress. In Shakespeare's *The Winter's Tale* Polixenes, King of Bohemia, railing against the abuses of the clever, and their 'art which in their piedness shares with great creating nature', wisely remarks:

*Yet nature is made better by no mean,
But nature makes that mean. so, over
that art,
Which you say adds to nature, is an art
That nature makes .
The art itself is nature*

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¹ Karl Marx. Economic and Philosophic Manuscripts of 1844 in: Karl Marx and Frederick Engels, *Collected Works*, Vol. 3 (Progress Publishers, Moscow, 1975), p. 200.

irreparable breakdowns in the weakened mechanism of natural processes. A mutual harmonious relation between man and nature has become as necessary as air in modern times. And that is an important condition for the triumph of humanist principles.

Though the unity of technically armed man and nature, however, has now been considerably disturbed, the disturbance is by no means irreversible. And while the increasing separation between man and nature is becoming extremely dangerous, it must be overcome, because man's physical and spiritual life is inextricably linked with nature. For men's history itself is a real part of the history of nature, and as men's history moves, so moves the history of nature—it is necessary simply not to permit serious breaches of the co-ordination of these movements. On that plane it is illegitimate to treat defence of nature as the ensurting of its absolute immutability. Such a treatment is theoretically metaphysical and utopian in practice.

The French ecologist René Dubos justly stresses that even a policy of the strictest conservation could not restore man's original environment, and that if such a position were achievable it would be undesirable! What is desirable for man, developing along the road of progress through the perfecting of labour, is a purposeful alteration of nature that does not remove natural conditions from the context of certain of the parameters that are most appropriate for life. The dialectical position is a scientifically reconstructed nature (including also along the line of

¹ René Dubos. *Man and His Ecosystem. The Establishment of a Dynamic Equilibrium with the Environment*. In: V. A. Kovalev (Ed.), *Biosfera i ego svet* (Nauka, Moscow, 1971), pp. 72-81.

the remote consequences for people's health) rather than an idealising of unaltered 'wild' nature. This position is based on the very essence of the labour process as one of rational transformation of natural material by means of technique. This transformation, while changing nature, can at the same time be co-ordinated with her objective possibilities.

On that plane projects for man's rational alteration of the climate with the object of achieving optimum conditions in the environment are of interest.¹

Through his ever growing technical power man is getting the chance in principle to make natural conditions accord with the technical need, subordinated in turn to the objective of maintaining a healthy environment on the Earth.

A number of projects for affecting the climate are being discussed today. There are, for example, proposals for altering ocean currents, such as to build a dam between Florida and Cuba to alter the regime of the Gulf Stream, and to affect the direction of the Labrador Current by means of a dam on the Grand Banks.²

There is also a scheme for creating a sea in Central Africa and the Sahara by regulating the flow of a number of African rivers; the sea's total area would cover 10 per cent of all Africa. These schemes are perhaps long-term but it is not impossible, given science's present state, to substantiate the consequences of such gigantic nature-transforming actions, without which, of

¹ M. I. Budyko *Izmeneniya klimata* (Changes of Climate). Gidrometeoizdat, Leningrad, 1974; Ch. 6, Man's Effect on Climate, pp. 189-216; Ch. 7, The Climate of the Future, pp. 217-66.

² *Ibid.*, p. 200.

CITIES AND THE ENVIRONMENT OF CONSERVING THE POLAR ICE CAPS FOR EVERMORE.

The idea of melting polar ice in the Arctic has been specifically proposed by Bush in his film on the Arctic State and creating a powerful system to pump the warmer waters of the Pacific Sea into the Arctic Ocean. In his analysis of this matter M. I. Budyko¹ rightly stresses that

by no means all the consequences of breaking up the polar ice for the climate and natural conditions of the various territories can now be foreseen with sufficient accuracy. It must therefore be considered that though the possibility of eliminating the ice exists, it would be inexpedient to undertake the measure in the immediate future.²

In bringing out the whole importance of the problems of conserving nature and its riches in his report to the 26th Congress of the CPSU, Leonid Brezhnev noted among the factors complicating economic development in the 80s 'the growth of expenditure due to developing the East and the North, and also the inevitable increase in spending on environmental protection'. Given planned scientific and technical development, growth of productivity, and the fight against the arms race, more and more favourable opportunities will be created in a society based on collective ownership for improving the biosphere.

¹ M. I. Budyko, *Op. cit.*, p. 250

² L. I. Brezhnev, *Report of the Central Committee of the CPSU to the XXVI Congress of the Communist Party of the Soviet Union, and the Immediate Tasks of the Party in Home and Foreign Policy*, p. 66.

Much progress can be made in complex analysis of the consequences of our technical actions by using ecoclimatic modelling and so prevent possible adverse technogenic effects on the climate. One such effect is the danger of overheating the planet by technogenic heat.

René Dubos, already quoted above, quite justly concludes that developed nature needs to be regarded not as an object to be preserved inviolable, and not as an object subjected to exploitation, but as a kind of garden that has to be tended with due account of its inherent possibilities and that will permit the people living in it to develop in accordance with their capabilities. The ideal would be for man and nature to coexist in unrestrictive, constructive conditions.

The very important philosophical conclusion follows from a methodological analysis of the modern ecological situation that ecological problems can only be tackled on the basis of dialectical logic and its conception of the universal connection of phenomena. Dialectical materialism provides a theoretical basis for ecology as a science; and materialist dialectics, organically uniting and combining the principles of the world's development and unity, motivates a monistic approach to man's relationship with his environment.

Given steady growth of technical power, voluntaristic arbitrariness or wilfulness is especially disastrous, because it involves a risk of irretrievable damage to nature's mechanisms that no subsequent, even greater scientific and technical growth will be able to correct.

At the same time calls for a complete halt to technical development completely for the sake of conserving nature are also an undoubted extreme.

That kind of call, in the spirit of the conception of socio-cultural dualism and pluralism, often made by bourgeois theoreticians to the public of developing countries, and is undoubtedly the worst kind of ecological pessimism. The attitudes are also encountered in developed countries themselves. This unsound ideological concept is based on the methodologically and politically bankrupt thesis that the ecological crisis is engendered by 'Western' culture (meaning not bourgeois civilisation but technological civilisation in general), and that the way out is to go over to an 'Eastern' type of civilisation (without technical development). Reactionary ecological pessimism is taken to the extreme in this view (let us reject technicised forms of work and return to nature). The constructiveness of this extreme is, of course, illusory. Methodologically it is built on a metaphysical dualist separation of the cultures of East and West and on an ignoring of the real trend in the industrialisation of developing countries. It is a conservative methodology of counterposing the present and the past (instead of deducing the future from the present).

To see the future in a rejection of 'Western technologism' in favour of 'Eastern submergence in nature' means to absolutise the split in mankind and to perpetuate backwardness.

On this plane ecological pessimism is born of antiscientism, inclined to ascribe the woes and difficulties of modern bourgeois civilisation to an alleged 'extreme' growth of science. Scientists have been converted from recent idols into scapegoats on whom all responsibility for the adverse consequences of scientific and technical progress is thrown. These attitudes have caused deep concern in scientific circles, and have been

the cause of a profound reappraisal of the role of scientists in the modern world. In this connection, the President of the World Federation of Scientific Workers, Prof C. H. S. Burhop, has written:

A major problem we have to face in the West is a general disenchantment with science and even the growth of an anti-science movement.

Science and the control over nature which scientific knowledge brings, is no longer regarded as something beneficial and good.¹

This is a common weakness of bourgeois theoreticians' socio-ecological analysis. Mesarović and Pestel tried to smooth it over in part in their *Mankind at the Turning Point*, but bourgeois forecasts are built at every step on the illegitimacy and undesirability of industrial and urban development of previously backward countries.

'The extreme forms of anti-technicism and anti-urbanism can be considered a variety of the ideology of neo-conservatism,'² Yanitsky concludes.

The scientific and industrial revolution is global in its nature and will ever more broadly embrace all countries and aspects of men's life and the actual experience of technical progress will itself bring out more and more fully the fundamental fact that the serious shortcomings of present forms of technical development, now becoming evident in regard to the environment, by no means prove that technique is inevitably incompatible with the biosphere. On the con-

¹ *Scientific World*, 1974, 18, 4: 11.

² O Yanitsky *Urbanizatsiya i ekologicheskie protivorechiya kapitalizma* (Urbanisation and the Social Contradictions of Capitalism), Nauka, Moscow, 1975, p. 293.

trary, the general strategy of technical progress is linked with the ecological and technological revolution that will have to restore a harmonious relationship between technique and the biosphere on a new, higher level. The outlines of this revolution are already becoming quite distinct (filters, a closed technology, an increase in the scale of the production of atomic energy that does not pollute the environment, new means of transport freed of the motor car's harmful exhausts, and so on)

Technical progress itself, we can conclude, not only does not rule out improvement of the quality of the environment but is its *sine qua non*. On the other hand, the natural environment's quality is becoming a kind of humanist criterion of the level of development of technique.

Under socialism planned control on a society-wide scale of the development of technique, and improvement of the quality of the environment can be mutually co-ordinated, harmonised, and optimised, i.e. brought into the best relationship for the given concrete conditions. Quite understandably, any optimisation acquires real, *concreto sensu* on the basis of certain real criteria. For the methodology of socialist nature—use the highest criterion of optimisation of the relation of technique and the biosphere is undoubtedly the factor of man's health, and effective equilibrium of his physical and psychic organisation.

Karl Marx and Frederick Engels, continuing the world materialist tradition as regards the relation of living human individuals and nature, stressed that

The first fact to be established is the physical organisation of these individuals and

their consequent relation to the rest of nature¹

The point stressed in this thesis about establishing man's interaction with nature not just as a social relation but also as the physical organisation of individuals in the modern ecological situation is becoming more and more important. The adverse technogenic change in the biosphere is leading, in fact, to a danger of gradual disruption of men's physical organisation. The existence of this danger, which has now attained alarming dimensions, is visible in the fact of the spread of a special kind of ecological illness caused by toxicants of industrial origin. Such is the illness discovered in Japan associated with the anomalous quantity of harmful substances in sea food.

Shifts are now even being observed in the chemical composition of the bodies of human beings themselves. There are data, for instance, that the skeleton of primitive man contained two milligrams of lead, while that of modern man has a lead content 50 to 100 times higher (mainly from motor car exhausts).²

With this pressure of technologically caused hazards to the human organism a new form of 'the domination of material relations over the individual' has appeared, about which Marx and Engels wrote when formulating 'the task of replacing the domination of circumstances and of chance over individuals by the domination of individuals over chance and circumstances'.³ This

¹ Karl Marx and Frederick Engels *The German Ideology. Collected Works*, Vol. 5 (Progress Publishers, Moscow, 1976), p. 31.

² E. M. Nikiforova *Heavy Metals Are Damaging the Biosphere* *Khimiya i zhizn'*, 1978, 1: 38.

³ Karl Marx and Frederick Engels *Op. cit.*, p. 438.

thesis is now becoming clear in its definite ecological aspect as well, an aspect connected with taking the consequences for people's health and the effect of technique on the biotope into account, and with overcomes these harmful consequences. Thus ecological content of socialist humanism has found full expression in the objectives set by the 25th Congress of the CPSU for improving socialist nature use.

Socialism, with its planned economic system and its common ownership of the instrument and means of production, is quite capable of avoiding technical developments such as would inflict irreparable harm on the health of the present and future generations of Soviet people. Prevention of this hazard is a multilevel problem on whose successful solution various branches of Soviet science and engineering are working.

In this respect an interdisciplinary systems approach is productive. The difficulties of combining multifarious facts in such a complicated field as the socio-ecological aspects of scientific and technical development are, of course, still very great, but in principle the technique of systems modelling, given scientific substantiation of its ideological and theoretical premises, and perfecting of formalised programmes that allow for the interaction of the various factors and ways of controlling them, will become ever more important. It is quite understandable that the most circumstantial integrative models can provide only a set of alternatives (possible scenarios) in the socio-ecological sphere, the choice of the alternatives depending on the socially significant action that has acquired a normative-prognostic character. By virtue of that the true integrated character of the solution of ecological problems is decided not only by the interaction

of the various sciences but also by the interaction of the various practical aspects of social affairs themselves, production and consumption and social and everyday behaviour

As for the outlook for perfecting the dynamic 'social development/resources/quality of the physical environment' system, one must stress how great is the role in this of an optimum relation of productive activity and a scientifically substantiated structure of consumption. Optimisation of the biosphere depends essentially on the optimisation of human needs.

Capitalism, with its fundamental lack of social uniformity on both a national and a global scale, reproduces constantly growing wealth at one pole and poverty at the other. This monstrous one sided 'wealth' is leading to man's subordination to an unrestrained bacchanalia of the replacement of things by other things.

By satisfying a feeling of 'consumer satisfaction' rather than real wants this wealth corrupts and enslaves man, making him a slave to material status symbols. Under capitalism this material wealth is developed *in opposition to man and at his expense.*¹

On the plane of our theme it must be stressed that this overconsumption by the 'chosen few' is increasing pressure on the environment and damaging everyone's health.

Bringing out the irrationality of bourgeois consumption, Karl Marx wrote: 'Private property has made us so stupid and one sided that an object is only ours when we have it'²

¹ V. G. Afanasev *Sotsial'naya informatsiya i upravlenie obshchestvom* (Social Information and the Management of Society). Nauka, Moscow, 1975, p. 152.

² Karl Marx Economic and Philosophic Manuscripts of 1844. Karl Marx and Frederick Engels. *Collected Works*, Vol. 1 (Lawrence & Wishart, London, 1975), p. 203.

Another metaphysical extreme is the anti-humanist theory and practice of the leadership of the Communist Party of China, which undermines the very foundations of workers' consumption. After the Tenth Congress of the CPC (August 1973) the following slogan was issued: 'Powerful State and a Poor People'; 'a striving for an easy life' and a desire 'to dress warmly and to eat one's fill' were declared 'reactionary capitalist views'.¹ In contrast to these distortions, truly scientific socialism is oriented on maximum satisfaction of the workers' wants, taking into account, of course, people's need for a healthy environment (the role of biospheric needs in the general structure of consumption will itself grow the more the building of communism develops). As for the optimum relation of production and consumption to the objective possibilities of the environment, the job of Soviet science is to substantiate it fully.

It was not by chance that the 26th Congress of the CPSU stressed the need to further develop scientific principles for the rational use and protection of the environment.

Fulfilment of that complicated task is, *inter alia*, an important condition for the successful building of communist society and will have universal human significance.

¹ M. L. Altaišky, On the Antihumanist Essence of Marxist Distortions of Socialism, A. G. Myshlycheiko and I. N. Suvorov (Eds.), *Problemy humanizma v marksistsko-lenskoi filosofii* (Politizdat, Moscow, 1973), p. 203.

THE SCIENTIFIC AND INDUSTRIAL REVOLUTION AND THE ECOLOGICAL PROBLEM

Unfavourable ecological conditions are known to have built up more than once in human history. But the situation in our epoch differs in principle from all previous forms of man's relation with nature, because the unfavourable factors in the environment are taking shape in conditions of a global development of the scientific and industrial revolution.

That fact necessarily underlies the whole analysis of the lines of future evolution of the super-complex dynamic 'nature/society' system and its whole contradictory character and at the same time unity of its components.

1.1. THE MONISTIC CONCEPTION OF THE RELATIONSHIP OF MAN AND NATURE

In today's scientific and industrial revolution the aspect of philosophical monism associated with the unity of man and nature is acquiring greater and greater importance. Man is the creation of nature, and without her his existence is impossible, but both the forms of the interaction and how far they are comprehended are constantly altering. Man has travelled a long way from an unequal and therefore inharmonious unity

with nature, when he was subject to her, to the equal and harmonious unity of technically powerful man with an environment that remains natural (In overcoming this inequality man has subordinated the environment by every means at his disposal.) Here we see a dialectical triad, though its synthesis has by no means yet been realised and now exists solely in the form of a task that, as is now clear, it is unbelievably difficult to perform.

During the whole of man's history he has been constantly interacting with the natural environment. As Marx put it, the labour process itself is one of exchange of material between man and nature, in the course of which 'he opposes himself to Nature as one of her own forces'.¹

Three forms are distinguishable in the historical development of this interaction.

The first is characterised by man's profound dependence on nature. Myth and religion serve as forms of its reflection in ideas. The 'little man' is lost before great, terrible nature. Man lives in constant fear which is due to the impossibility of winning from nature the vital means needed for existence.

Analysing the spiritual world of the village communities of antiquity, Marx wrote in his despatch 'The British Rule in India' that

they subjugated man to external circumstances instead of elevating man the sovereign of circumstances, that they transformed a self-developing social state into never changing natural destiny.²

¹ Karl Marx, *Capital*, Vol. I. Translated by Samuel Moore and Edward Aveling (Progress Publishers, Moscow, 1978), p. 173.

² Karl Marx and Frederick Engels, *Collected Works*, Vol. 12 (Progress Publishers, Moscow, 1979), p. 132.

The second form of the interaction of man and the environment is realised in practice in progressing production and ideally fixed in science. It receives full development in the epoch of machine industry that began in England 200 years ago. It is linked with a process of taming nature on an ever-growing scale. The 'man/nature' relationship is a relation of conqueror and conquered. Newer and newer objective processes of nature are subordinated to man. The forces of industry, more powerful than ever before, act on the forces of nature. At this stage nature interests man mainly from the angle of food, material, and energy resources.

The special nature of the third, modern form of the interaction of man and the environment comes out in substantial disturbances of the dynamic equilibrium of the 'industry/nature' relationship. The problem of the biosphere's renewable resources is becoming especially complex. The procedure for disposing of industrial wastes is becoming more and more complicated, and it is becoming more and more difficult to supply man and his production with relatively clean air and fresh water.¹

In recent years there has been much talk about modern civilisation's 'ecological crisis'. What is the case now? For man's activity has always been accompanied with wastes of some sort. Archaeology bears witness, for instance, that special places were already being set aside in ancient caves for the bones of animals caught in the chase and eaten. And so it has seemingly been in any civilisation. So it was in the past century. A modern guide book to Kursk, for

¹ UNESCO Courier even flew a distress signal of sorts in July 1971 SOS—Save the Environment!

example, says that the Chief of Police issued an order in 1827 on 'moving establishments that produce stinks and fumes beyond the city limits.'

But every society tackles these problems its own way. Conflict situations in the environment are exacerbated by the social system of private enterprise. It is not by chance that the motif of the unnaturalness of capitalist industry is so strong in the Western literature of critical realism. One long remembers the description in the 'valley of ashes' in F. Scott Fitzgerald's classic American novel:

About half way between West Egg and New York the motor road hastily joins the railroad and runs beside it for a quarter of a mile, so as to shrink away from a certain desolate area of land. This is a valley of ashes—a fantastic farm where ashes grow like wheat into ridges and hills and grotesque gardens; where ashes take the forms of houses and chimneys and rising smoke and, finally with a transcendent effort, of ash-gray men, who move dimly and already crumbling through the powdery air. Occasionally a line of gray cars crawl along an invisible track, gives out a ghastly creak, and comes to rest, and immediately the ash-gray men swarm up with leaden spades and stir up an impenetrable cloud, which screens their obscure operations from your sight.¹

The United States, of course, beats all 'records' as regards pollution of the biosphere

¹ Kursk Boronoch, Moscow, 1954, p. 71.
F. Scott Fitzgerald. *The Great Gatsby* (Verlagshaus, New York, 1925), p. 27.

The largest international exploiter and destroyer of nature, the United States contributes about 40 per cent of the planet's pollution,

Philip Hart said at the international symposium on Marxism-Leninism and problems of protection of the environment sponsored by *World Marxist Review (Problems of Peace and Socialism)* in 1972.¹

Of course it is not science and technique by themselves that threaten mankind's biological existence and the extinction of all life on the Earth but the aggressive capitalist form of the attitude to nature, the private property character of the use of natural resources for the sake of gain, and the arms race, absorbing a mass of forces and means. Relaxation of international tension, on the contrary, reduction of arms spending, and measures to prevent world war would facilitate solution of the ecological problem. We need to pass from the stage of aggressive taming of nature to the stage of harmonising the complex 'man and his habitat' system. Movement along the road of harmonising human production and the environment calls both for scientific treatment and for a reconstruction of industries, for which, of course, considerable financial resources would be required. Nature, which once terrified men by her 'incomprehensibility', now frightens man by its infirmity, and the fragility of its intimate mechanisms. The fear experienced by man in the past before alien, terrible nature has given way today to fear of the unco-ordinated powers of modern industry. The whole process of the interaction of man and nature, and of society and nature, has begun to acquire paradoxical features.

¹ *World Marxist Review*, 1972, 6:21

Man's genesis has appeared from its very start as a process of the differentiation from oriture of a natural, rational creature over and above nature. That fact engendered a split between the human and the natural, the artificial (technical, from Greek *tekhnē* art) and the natural (unaffected). The dualism of man and nature provided the real soil from which the fundamental question of philosophy, and the two lines answering it, have grown. While the old materialism absolutised man's naturalness and closed the road for it to understand the action of the human mind or spirit, idealism abstracted the supernatural character of man and so reduced his activity to voluntaristic arbitrariness.

Because of these two extreme points of view the 'man/nature' concept was long considered from the standpoint of dualistic limitations, overcoming of which is the principal, methodological condition for the development of a synthetic conception of the real unity of man + nature.

On the plane of systematisation, it is useful, in our view, to single out six kinds of such dualistic extremes in understanding of the 'man/nature' relation:

1. The process of man's interaction with his habitat is one, to its inner essence, of humanising nature, but this true formula has often been interpreted in a one-sided way (and still is!) simply as a process of taming or conquering nature. In that approach nature functions as something absolutely passive, from which one must necessarily get what is good, without waiting for

¹ For a historical and philosophical survey of views on the later relationship of man and nature see V. A. Los, *Chelovek i priroda (Man and Nature)*, Politizdat Moscow 1974.

nature's answer to this 'resolute grabbing', and without asking nature whether she can infinitely yield this good.

The tamer and the tamed are quite understandably in a dichotomy. And since nature is not passive at all, she takes revenge on the man who scorns her laws.

Frederick Engels was warning against one-sided conqueror's illusions, dualist in their methodological essence, of course, when he wrote:

Let us not, however, flatter ourselves over-much on account of our human victories over nature. For each such victory nature takes its revenge on us. Each victory, it is true, in the first place brings about the results we expected, but in the second and third places it has quite different, unforeseen effects which only too often cancel the first.¹

The gap between the goal and the result in the interaction with the environment is an extreme form of the dualist approach to the 'man/nature' system.

2 The formula of environmental protection also acquires a dualist tinge when it is interpreted as defence from man and even against man. At the 15th International Congress of Philosophy (Varna, 1973), A J Ayer spoke of man's chauvinism in relation to everything living. Such pessimism leads to the conclusion that man's sins against nature, constantly accumulating, have already gone beyond all permissible bounds and that, whatever men undertake, they are already doomed to death, though they have not sensed it, because of the irreversible and irreparable dam-

¹ Frederick Engels *Dialectics of Nature* (Progress Publishers, Moscow, 1974), p. 80.

age already done to nature's mechanism. Such a nature's advocate stand is anti-human in final analysis; it is directed against man and discourages man, inspiring him with the idea that whatever he does death is inevitable all the time on the doomed planet.

In order this approach rejects the fundamental principle of human being which Hegel aptly called the 'industry principle'.

Likewise the industry principle contains the opposite of what we get from nature; then the natural object is worked up for use and ornament. In industry man is an object for himself and treats nature as something subjugated by him, on which he has stamped the seal of his activity. His intelligence is bravery, and skill is something more than just natural courage. We see the people emancipated here from fear of nature and servile service to her.¹

The conception of ecological pessimism (sometimes going as far as ecological extremism) is a form of modern ecological dualism.

3. The conception of environmental protection as its immutability frequently met is a form of expression of dualist limitations in understanding the 'man/nature' relationship, since concepts 'movement' and 'rest' are developed in it, with the leading role of movement obscured. Defence of nature is not some kind of metaphysical principle of timeless maintenance of the status quo in nature. The idea that some sort of inventory of nature can be drawn up once and for all and then passed on unaltered from generation to generation is quite illusory in practice. On the

¹ G. W. F. Hegel, *Vorlesungen über die Philosophie der Geschichte*, *Sämtliche Werke*, Vol. II (Fromme Verlag [H. Kortz], Stuttgart, 1928), p. 256.

parallel with a monistic consciousness of the unity of natural and social processes, and accordingly with a methodological style of thought oriented on overcoming the traditional gap between the natural and the social sciences and on integrating the scientific conception of nature and society in a unity or integral whole.

This monistic methodology comes out (though often not consistently) in the alarmist pessimism of several Western writers who doubt the capitalist's possibility, as a social system, to deal liability and fundamentally enough with the ecological problem.¹

The spokesmen of alarmist pessimism, who not, on the whole, breaking with the liberal prejudices of capitalist consciousness, are, at the same time, understanding more and more clearly that natural resources have been 'plundered bit by bit'. Private property on land and its natural wealth has not only led to an ignoring of nature as a whole but has also resulted in her plundering, poisoning, and annihilation.

6. The serious methodological danger of having a monistic orientation when dealing with the ecological problem is associated with that aspect of the dualist approach that can be called socio-cultural dualism. This kind of illusory construction is built on the thesis that the ecological crisis is the outcome of 'Western' (technological) civilisation and that the way out consists in going over to an Eastern (atechnological) type of civilisation. Ecological pessimism is taken to the extreme limit here and operates in the form of eco-

¹ K. J. Shillie surveys the views of alarmist pessimists in his paper on the ecological turning point in U.S. science in L. S. Abramov, I. B. Novik et al (Eds.), *Pravmoderstvo prirody i obshchestva* (USSR Academy of Sciences, Moscow, 1973), pp. 53-70.

logical extremism (a kind of ecological Luddism). The elegiac passivity of pessimism is transformed into extreme radical action ('let us renounce technological forms of work and merge with nature'). The constructiveness of this extreme is, of course, illusory, for (as noted earlier) it is built, methodologically, on a metaphysical, dualist break between the cultures of West and East and on an ignoring of developing countries' need to industrialise. It is a methodology of dualist counterposing of past and present, instead of monistic deduction of the future from the present.

To see the future in a rejection of Western technologism simply through oriental submergence in nature is to absolutise scientific and technical backwardness. 'Technicised labour' is becoming more and more common on our planet, but it undoubtedly has to be reorganized, especially in relation to the environment (including taking the rational moments of the Orient's experience into account, though we must not lose sight of the fact that there was often no real affinity with nature in 'Oriental societies' but a dissolving of a still immature society into the environment).

Hegel, bringing out the inner unsoundness of what he called 'the Oriental world', wrote that 'nature is the head' in it.¹ Characterising the culture of the Phoenicians as transitional to the 'Greek world', he wrote that 'a quite new principle followed from this'

Passivity came to an end, and also simple brute courage: in their place came the activity of industry and prudent valour, audacious sailing of the sea, and taking reason-

¹ G. W. F. Hegel, *Op. cit.*, p. 201.

able care of the means. Here everything is staked on man's activity, his daring, intelligence; and there are also goals him. Human will and activity are primary here, not nature and her goodness. Babur had its definite soil, and livelihood was determined by the course of the sun and the motion of nature in general. But the Englishman relied on himself in the welter of waves, and eye and heart had always to open.'

Hegel's historical comparisons are very interesting despite their idealistic basis. The fact is, of course, that Ancient Greece had the highest form of organisation of production under slavery.

The trend toward 'Orientalism' common now in the West (especially among some of the youth) is a distorted Idealist form and a reaction to the actual crisis of the capitalist form of civilisation.

Abstractness in the worst sense of the term is inherent in sociocultural dualism. By neglecting the role of historical analogies (which I am resolutely opposed, as we know), neglecting to analyse the real trends of development of modern mankind, and not bothering to become familiar with the data of the natural sciences (so significant though quite insufficient) characterising anthropogenic effects on non-anthropogenic processes, a kind of utopian 'social philosophy' (by analogy with natural philosophy) is built up on the basis of a dualistically speculative approach. Natural philosophy was long ago condemned by Marxist methodology as an index of the immaturity of scientific thought and as an attempt to come to an equilibrium, perspectives upon which cannot be given any connections for further development.

(c) W. F. Hegel Op. cit., p. 224

ly studied real ones. This type of epistemological approach must also, however, be refuted in a social science context when it spreads in our time as a kind of arbitrary scheme of anthropogenesis not based on empirical, archaeological, ethnological, palaeontological findings and the data of the study of religion and other disciplines. Arbitrary constructions of this kind are inimical to the methodological experience of Marxism, which always bases its generalisations on facts (an example of that is Engels' study of the origin of the family, solidly founded on Morgan's factual material).

Dualism, which is generally inherent in bourgeois consciousness, is also manifested in various ways and forms of reflection on the ecological problem as one of developing modern forms of man's interaction with his natural environment.

There was a split in the 1960s between the 'optimists' (supporters of the establishment) and the 'pessimists' (criticising the capitalist social form of man's relation to nature) over the very posing of the problem in the United States. Ecological pessimism was divided in turn into the 'alarmist pessimists' who warned against the disastrous consequences of uncontrolled industrial growth but who rejected the possibility of a way out of the current ecological crisis, which was acquiring a global character, and the 'extremist ecological pessimists' who asserted that mankind had already caused irremediable harm to nature's mechanisms by its technological impact and was doomed to extinction because of that.

The methodological basis of views of that kind constitutes a dualism together with conceptions of the 'tragic' dialectic in understanding of the relation of man and nature as an antagonistic break between them.

The ecological crisis intensified by capitalism is refracted in the consciousness of some capitalist writers in a panic-stricken conception of hopeless ecological pessimism. In the French researcher Jean Dorst's *Avant que nature meure*, for instance, which is oriented on the whole on defence of nature (with a wealth of material), one can find such unsubstantiated generalisations as that modern man 'has got on to a run-away train from which he cannot get off'.¹ That conclusion does not correspond to the data of modern science and industrial practice. The problem is becoming a burning one, but is not at all finally hopeless. A mood of doom is, by its very nature, anti-scientific and anti-human.

What is important for real human progress (a condition of which is to solve the problem of the disorganisation of the biosphere), quite understandably, is not helpless moaning about what has happened but constructive measures on a national and international scale to protect the environment. The decisions of the 26th Congress of the CPSU, for instance, were oriented on such measures. This line calls for a further research into both the social and the naturalist aspects of the biosphere in their ever more fully disclosed unity, based on a monistic methodology.

It is on the basis of a monistic methodology that ideas on the protection of the environment are being worked out in developed socialist society in this era of the scientific and industrial revolution. The strategic task posed by the Soviet society was not to permit a dualist break between the fruits of technical progress and the mechanisms of improving the conditions of men's life on

¹ See Dorst, *Avant que nature meure* (Delachaux et Niestlé, Neuchâtel, Suisse, 1963), p. 11.

earth, but to merge them organically. The task of uniting the achievements of the scientific and industrial revolution with the advantages of the socialist system includes, as a most important element, intensification of the struggle to conserve and improve the environment. Man is of decisive importance in the 'man/nature' relationship because he functions both as controller of the evolution of this relation and as the criterion of improvement of the 'society/nature' interaction. Monism assumes a single point of view on the ecological problem—that of the interests of man himself, of his prosperity and perfection on a transformed but not disrupted Earth in a unity of two forms of objective process, viz. nature and man's goal-directed activity.

These two forms, however, are clashing more and more in the modern world and their contradiction threatens to grow to conflict proportions. They need to be merged in a single formation in the interests of the knowing and acting subject. This merging will appear theoretically as the highest stage in the development of monism and in practice will create the most favourable conditions for uniting subject and object in the course of man's progressive evolution.

The man of developed socialist society not only needs a social environment worthy of him but also a corresponding natural one.

The conserved and improved natural environment has to meet all man's biospheric needs, which are becoming ever more important. In the hierarchy of *Homo sapiens*' needs, that of living, unspoilt nature will assume ever greater weight.

Because of that, protection of the environment is becoming, under common, social ownership, a special form of planned activity that it is necessary to organise in the best possible way. In the

Soviet Union the humanist principle of everything for man's sake is made the cornerstone that

Measures to protect nature are not a one-and-for-all campaign. The job calls for a steady stage-by-stage restructuring of industry and agriculture so thorough-going that it can be called technological revolution designed to replace production harmful to nature by a qualitatively new one harmonised with her.

In order to implement the whole complex of planned measures successfully we must take into account and allow for the need for broad development of research aimed at an optimum combination of production and the environment and the most rational use of natural resources, and at foreseeing and overcoming possible adverse effects of technical development as regards the environment. The role of pure science and methodological work as well as of applied research is increasing in the solution of these tasks.

To end the present pollution of the planet is not just the noble wish of a dirt-abhorring aesthete but a condition of man's survival. A closed circuit of mutual influence is taking shape here, viz. social conditions influence solution of the ecological problem, while the perfecting of both social conditions and man himself depends in turn on successful, timely tackling of the ecological problem. That perfecting will not be furthered, of course, by technophobic utopias of a return to a machineless age or provocative views counterposing the industrial West to an East alien to the industrial race. The way out is not either in the extremes of antitechnicist panic-mongering or in preserving the present *status quo* of a deteriorated biosphere, but in restoring the unity of man and nature through social prog-

ress on a planet-wide scale. The young Engels had already stressed that the coming transformation would mean 'the reconciliation of mankind with nature'.¹

This transformation postulates both a change in social relations and a radical restructuring of human productive activity.

It has often happened in history that a once poorly understood problem has suddenly become unexpectedly acute and even dramatic. In past decades, in fact, natural resources aroused man's great interest in his relations with nature. Now the problem of the wastes of his production activity is coming to the fore in an ever more complicated form. And the simple fact that the Earth is not simply the source of the wealth of nations but is also the receptacle of the products of their activity.

All-round comprehension both of the practical urgency and of the fundamental theoretical significance of this new ecological situation can help us find the optimum road to overcoming the contradictions associated with pollution of man's habitat. Wastes, of course, are only a moment of the wider problem of utilising nature under the current scientific and industrial revolution, a problem that has matured and must be resolved.

In a planned economy, taking its advantages into account, the responsibility of ministries and departments, enterprises, institutions, and organisations for rational use of natural resources (land, water, the atmosphere, minerals), and for reproduction of the flora and fauna, is rising all the time.

¹ Frederick Engels, *Outlines of a Critique of Political Economy*. Karl Marx and Frederick Engels, Collected Works, Vol. 3 (Progress Publishers, Moscow, 1975), p. 424.

The monistic understanding of the 'man/nature' relation by no means signifies a rejection of activity; on the contrary, it is oriented on the further development of such, and its transformation in accordance with the trends of the whole biosphere's evolution. Restoration of man's affinity for nature—of a feeling for nature—will not be brought about by rejecting civilisation but only through an ecological reconstruction of the technical foundation of society and of all aspects of civilisation.

Karl Marx stressed that

the abstract enmity between sense and spirit is necessary so long as the human feeling for nature, the human sense of nature, and therefore also the *natural* sense of man, are not yet produced by man's own labour.¹

The development of a monistic methodological conception of the unity of man and nature must be developed in the conditions of the scientific and industrial revolution on bringing out the main methodological features of today's ecological situation.

The underlying methodological cause of all these features (which will be subsequently considered) is breach of a monistic orientation on the unity of man and nature for the sake of man's progressive development on Earth.

The unity of man and nature objectively disrupted in the course of practical activity calls for a consolidating of the monistic methodological trend in analysis of the ecological problem ^{as} its theoretical compensation. Until that problem is tackled mankind cannot advance. In spite of

¹ Karl Marx, Economic and Philosophic Manuscripts of 1844. In: Karl Marx and Frederick Engels, Collected Works, Vol. 3 (Progress Publishers, Moscow, 1975), p. 312.

the qualitatively different posing of the problem and means of dealing with it in different social systems, it has an essential, global moment that is global, moreover, not simply as regards space but also on the plane of the all-penetrating, all-embracing character of the ecologisation of all forms of cognition and activity.

Methodological analysis includes three elements (a) exposition or the philosophical differentiation of the leading features of the present-day ecological situation as elements of real life; (b) reflection (meditation) or consideration of the reflection of these features of life in the structure of science as rational activity, (c) methodological evaluation of the outlook for a solution of the ecological problem (the ways and possibilities of optimising the biosphere)

1.2 FEATURES OF THE PRESENT-DAY ECOLOGICAL SITUATION

The quite acute resource aspect of the environment is being supplemented in our day by a no less acute assimilation aspect. The important interaction of these two aspects is the most characteristic feature of the present-day ecological situation. Not only is the provision of natural factors for human activity proving to be problematical but so too is nature's capacity to assimilate the consequences of that activity.

The contradictions developing between technicised man and a nature experiencing a mounting technical effect are acquiring a paradoxical form today, so that the features of the current ecological situation as fragments of reality can be represented as paradoxes of the biosphere's development.

The Three Main Ecological Paradoxes

Given technical growth unco-ordinated wth the biosphere's possibilities, the evolution of nature's bifunctional character (i.e. its capacity serve at once as the initial basis of products and as a reservoir in which the wastes and products of human activity are assimilated) is reaching a certain extreme point, which is leading in our view, to three main paradoxes in the current ecological situation

1. The first of these paradoxes can be called that of 'saturation'. For thousands of years man's disturbing effect on nature was relatively slight and the biosphere more or less reliably performed two mutually exclusive functions, viz that of serving as the source of man's means of existence and at the same time as the receptacle of the wastes of his activity.

The contradiction of these two highly important functions of the environment was early present in man's activity but only potentially so, because of the small scale of his production activity and because the character of the products and wastes was such that they admitted of comparatively easy repeated assimilation by nature. Stone tools, for instance, and equally the wastes of making them, were organically added to the stones that existed in the environment undisturbed by man's activity. The products of pottery only modified the clay existing in nature. Wooden articles rotted in the ground in almost the same way as dead trees in the forest. Metal was comparatively small in volume and corrosion gradually 'reworked' it. The products made by man were close to nature.

Man's activity, in becoming more and more mediated, has tended to become steadily more

and more remote from the initial 'body of nature', as it were. His reactions with the natural environment (which engendered man himself at a certain level of its development) are gradually getting more and more out of step. The result is, in many cases, that human activity, sound in relation to its direct product, which meets some need or another (sometimes far from vitally important), acquires elements of an irrational, unwise order in relation to production's consequences for the biosphere. The labour process, uncoordinated in its consequences, which originally took shape as the human means of surviving in the environment, is beginning to damage the biosphere and consequently also man's biological structure. That, however, does not express some sort of immanent viciousness, or 'antibiologicality' of labour but, on the contrary, is categorically posing the problem of passing from anti-biospheric forms of work to a form in harmony with nature.

During man's evolution his biological structure was not only negated by labour but was the permanent basis for it, since it proved well adjusted to the relatively stable parameters of the environment and was even their product in a certain sense (e.g. man's hands). The outstanding classical physicist Boltzmann had already remarked in the last century that, in the course of evolution, a capacity of different bits of matter to reflect properties of the reality around them, and to determine the place of 'favourable living conditions' had arisen¹.

The stable parameters of these 'favourable living conditions' were not essentially altered ei

¹ Ludwig Boltzmann *Populäre Schriften* (Verlag Barth, Leipzig, 1925), p. 49.

ther by the effect of natural forces or by the action of anthropogenic factors. Life, moreover transformed the natural environment biogeographically that the planet's evolution took on whose a pro-anthropic direction. Now, how are objective elements of a serious conflict associated with the fact that the earlier, on the whole pro-anthropic, character of the links of biosphere's biogenic and abiogenic parameters acquiring menacing anti-anthropic features?

In Lenin's *Philosophical Notebooks* (in his conspectus of Hegel's *Science of Logic*—Sect. Three, Chapter 1, Life) he copied out the following profound consideration of Hegel's from the *Encyclopaedia of the Philosophical Sciences* Outline:

Inorganic nature which is subdued by living being suffers this because it is itself the same as life is for itself.¹

Lenin interpreted this dialectical thesis as follows:

Invert it = pure materialism. Excellent, profound, correct!! And also NB shows how extremely correct and apt are the terms 'an sich' and 'für sich'!!!²

Man evolved as a nature engendered creature and acted to a certain limit in the same direction as the trends of nature. But in given technical development not harmonised with the biosphere, man comes into conflict with nature by producing 'for himself', and nature is passing from a passive state 'in itself' to an active state 'against him' (man). Since man is often, at the present stage of technical development, saturat-

¹ Cited by Lenin from Hegel, *Werke*, Vol. 6 (Berlin 1840), § 219.

² V. I. Lenin, *Collected Works*, Vol. 23 (Progress Publishers, Moscow, 1976), p. 202.

ing his habitat with a very sizable amount of harmful substances, without noticing it, the biosphere is beginning to be unable to neutralise them.

2 The chemical components of water, air, and the soil are being deeply altered by a production process unco-ordinated with the biosphere. We can, it seems to us, speak of a 'second paradox' on this plane, the 'displacement paradox', which consists in this that man, engendered by definite objective conditions, is gradually shifting them beyond tolerable limits in the course of his technological development which is leading to a disorganisation of, and 'organised chaos' in, the environment.

The emerging shift in the principal physical parameters of man's habitat is fundamental and dangerous: this habitat can only exist within a certain range of temperatures, with a definite level of radiation, a definite strength of the electromagnetic field, a definite intensity of sound waves, and so on. There are grounds, it seems to us, for speaking of a radiation sphere, thermosphere, and phonosphere in addition to such elements of the biosphere as the atmosphere, hydrosphere, and phytosphere.

The shift in the conditions of these physical spheres must not reach an intensity fatal to man. That is unavoidable, but here we come up against fundamental theoretical difficulties. It is known that our planet is being heated through the effect of several anthropogenic factors, mainly the consequences of the working of every sort of technological installation, and moreover at a very dangerous rate—the proportion of technological heat in relation to the heat received from the Sun (while still hundredths of 1 per cent) has a tendency to double every ten years. By the

xxviii of the next century of the planet's environmental shift in the third moment the consequences.

The rise in the planet's surface temperature, ground and shifts in other physical parameters of the environment, possibly due to greenhouse effect or otherwise, a result of the global warming of the atmosphere would have a salutary effect on the environment itself but a salutary effect on the environment would be a salutary benefit to the green house productivity. Productivity in the green house biological membranes sun plants annual plants are now feasible. The heart of the matter is that much more carbon dioxide is being formed on the Earth in one day than can be assimilated by vegetation. Measures are now being taken to raise the "productivity" of vegetation and to increase its biomass. It is not an easy matter and the planet, however, is becoming saturated by anthropogenic products through technical development. It has been shown that pesticides, herbicides, and antibiotics affect the intensity of photosynthesis, the most important mechanism for purposeful accumulation of solar energy in animal organisms.

3 If anthropogenic influences harmful for the biosphere are not stopped we risk coming up against a third paradox, that of 'replacement'. When the higher forms of life evolved over millions of years will be replaced, or rather displaced by lower forms, standing on a lower rung of the biological ladder. Many insects and bacteria, as we know, become adapted comparatively quickly to strong chemical, and even physical (e. g. radiation), factors. They are more labile because they are simpler, and by mutating continue a modified existence. Man, however, is a very complex biological system (especially because of the miraculous delicacy of the genetic apparatus) and either dies from the effect of a mark-

ed shift in the chemical and physical parameters or yields unsuitable offspring, which harbours a danger of degeneration of the biological species *Homo sapiens*.

On the ecological plane the paradox of the replacement of higher forms of life by lower ones leads to a simplification of the trophic chains, which undermines the stability of the existence of life, including man. For the most important law of ecology is that trophic chains are the more stable the more complex and indirect they are. Leaving out or missing any link in the chain in practice reduces its stability.

The environment shaping factors of one species of life or another have still been poorly studied, but what we already know in this field orients us on extreme caution in relation to affecting the trophic chains built up in the course of evolution. In the papers of one ecological conference it was emphasised that:

if animals did not eat these algae continuously and in vast quantity the latter would multiply to such an extent as to cause a shortage of the mineral salts they need and worsen illumination in the depths of the water.¹

Even one ill-considered 'anti-biospheric' act easily causes a chain reaction capable of doing irreversible harm to life. Irreversible breakdown of the mechanisms of the biosphere's dynamic equilibrium leads to the replacement of progressive forms of life by regressive ones, i.e. to a process of the 'regressing' (and possibly complete

¹ Yu. A. Isakov, D. V. Panfilov Basic Aspects of Animals' Environment Shaping Activity In: Yu. A. Isakov et al (Eds). *Sverdoobrazuyushchaya deyatel'*nost' zhivotnykh (Materials k soveshchaniyu 17-18 dekabrya 1970g) MGU Press, Moscow, 1970, p. 40

extinction) of life. That cannot be permitted. It is necessary to make a reasonable compromise between scientific and technical development & the biosphere, i.e. to make technique biopre-compatible. In that connection the problem arises of optimising both the biosphere and men's activity. In optimising the relationship of technique and the biosphere on this principle we obviously have to introduce certain rational limitations on men's activity so as to equate the transformation and conservation of nature. With planned compensation these limitations should not retard mankind's progressive development.

Ecology and Urbanisation

The manifestations of these main paradoxes have been greatly intensified in modern cities, which makes it possible, in our opinion, to speak of two additional paradoxes essentially aggravating the present-day ecological situation.

One of the essential features of man's interaction with the natural environment today, with the scientific and industrial revolution, is linked with accelerated development of special settlements on the surface of the planet, that can be called the urbosphere. Growing cities form continuous elements, a kind of urboquantum.¹

Urboquanta have the best conditions for displaying man's social nature; they meet the needs

¹ A propos of this term of ours it was remarked in one discussion that quanta are all alike and cities different. In relation to the biosphere, however, cities reveal many moments identically harmful to man. The world 'urboquanta', in our opinion, reflects the element of modern urban 'settlements' discontinuousness, although said settlements are occupying more and more territory.

of modern industry and people's social needs, and are therefore constantly growing. But the urbsphere is harmful in many ways for man's biological structure. And that is one of the real paradoxes of technical civilisation.

The most important elements of the urbsphere's anti-hygienic character are the products of urbanisation such as asphalt ('asphalt civilisation'), the products of the functioning of technical installations of various kinds, carbon monoxide and exhaust gases, various artificial chemical compounds, especially macromolecular ones. The harmful effect of these elements on man and all higher forms of life is obvious.

While the number of noxious factors is still adequately dispersed on the global scale of the whole biosphere, and has not reached critical dimensions, the menacing elements of the environment are taking a more concentrated form in the urbsphere's conditions. Hence the fourth paradox, which can be called 'the paradox of urban concentration', is that extremal menacing conditions are appearing much earlier for a significant part of the Earth's population (and in the long term for the majority) and for townsmen (and the majority are making for the city) than on the scale of the biosphere as a whole. Indeed, for the Londoner dying of smog, or the Tokyo citizen forced, because of motor-car exhausts, to buy relatively clean air at automatic street dispensers, things are no easier for knowing that there are still many places in rural localities with bracing ozone and delightful clean air; the people living in towns, forced to toil everyday in order to live, cannot breathe in the country on work days.

The difficulties in the functioning of the urbsphere are also intensified by the not unim-

Another fact that must not be overlooked is the effect of the weight of the Earth's crust on processes of human life, including the biosphere. For instance, gravity, far from being an obstacle to man's development in the environment, may have a positive effect on the biosphere. Because of the enormous pressure of the atmosphere, it is a source of water-table, and other factors) than climatic, the action of a chemical marks (the same materials can often be cleaned but it is impossible to eliminate hard surfaces made because living beings of their living arteries). No less a proof of this comes in that remarkable achievement of humanity—the superhighway airline. It is not only the task of bringing cities and continents closer together but also competes strongly with man an abundance of oxygen (not to mention the beauty of the sound and of the exhaust of the engines). Man's habitat, too, it is important to note, can change.

The force of gravity existing on the Earth, for instance, has as we know, played an essential role in the evolution of vertebrates.¹ The bone system, so arranged as to overcome gravity, fostered the forming of new haemopoietic systems in land animals that intensified oxygen metabolism, and led finally to progress of an exceptionally oxygenophilic organ, the brain. But artificial hills—city skyscrapers—can, after all, have unexpected effects on man. The effect of the sagging of the Earth's crust under the weight of huge, heavy cities, moreover, is already now to

¹ In an article "Gravitational Biology" (in *Pravda* 7 January 1974), N. N. Dubinin specially stressed the importance of developing a biological theory of gravity studying the connection between biological and gravitational processes.

2

THE PHILOSOPHICAL MEANING OF TODAY'S ECOLOGICAL CRISIS

Wording the ecological problem in the language of philosophical categories can contribute to a rational solution. Such help is real if only by virtue of the fact that the link with the conditions of the cognitive process (which has often countered complex problems many times and often found rational solutions for them) comes more clearly in philosophical analysis.

If the paradoxes of the current ecological situation outlined in the preceding chapter are to be given philosophical reflection, it will necessitate, first of all, a review of three key methodological relations in the material of investigation of the biosphere, namely: the interaction of the finite and infinite, the unity of change and conservation; and the interpenetration of the possible and impossible.

2.1. THE FINITE AND INFINITE ASPECTS

The traditional human attitude to nature was based on an idea of virtual infinity. And although men long ago perceived a certain boundary, say, green from not-green and

so proving the limitations of the earth, nevertheless that boundary was an abstract one so remote from men's real needs that it was naturally ignored in practical life.¹³

Our distant ancestors perhaps had a primitive unconscious idea of infinity, which for him was connected with the countlessness for example of the mammoths that provided sufficient hunters with sustenance. The finiteness of those animals themselves would have put an end to such an idea, but in the early periods of human history realisation of the aspects of finiteness was inseparably linked with a transition to new forms of virtual infinity. Discovery of the finiteness of some concrete form of natural resource gave rise to a need to pass to the use of other forms of relatively infinite resources.

The finiteness of game thus created the pre-conditions for passing to agriculture as a means of obtaining food from its virtually infinite—relatively—reserve of land suitable for the purpose. The leading aspect of the contradiction in the finite/infinite relationship in the 'man/nature' system was the infinite. That left its mark, in particular, on the evolution of mankind's power availability, from low-efficiency wood fuel men passed to fossil fuel. The harnessing of thermonuclear energy would again 'revive' the category of virtual infinity in the sphere of energy resources.

It is production, constantly advancing through the development of science, that is the real social form of man's acquaintance with infinity, a form of the triumph of the infinite over the finite in the field of natural resources. In other words nature is finite for him who does not perfect production and is, at the same time, infinite for those oriented on scientific and technical prog-

ress. In the course of this progress the content of the biosphere is itself generalised, and ever newer and newer components of nature are brought into it. That is how matters stand with nature's resource function. But how do they stand with her assimilation function? In that connection another question arises, viz. whether we are cutting up against a new form of finiteness of the modern ecological situation, i.e. with the absolute limitedness of nature's capacity to assimilate the consequences of men's scientific and industrial activity without irreparable damage.

In order to go into this question let us consider it historically. In previous periods one and the same forms of interaction with the environment existed for a long time. Only a small part of the available natural resources was used and each of them in small volume and with low efficiency. Man's effect on the planet as a whole was generally insignificant.

Today almost the whole surface of the Earth is a universal object of human activity. Circumterrestrial space and the shelf zones of the ocean have begun to be mastered. The range of conditions in which man can live and function has been immensely broadened, people are effectively protected from unfavourable environmental phenomena even in outer space and at maximum depths in the ocean.

Mankind has drawn almost all the renewable and non-renewable natural resources occurring near the ground surface into its activity. There still is a small degree, others in a significant fraction or almost wholly their activity is radically altering the natural course of some processes proceeding on the Earth's surface, and we are beginning to acquire proficiency in controlling some of them.

The modern ecological situation as a whole, and in particular the rapid rise in the specific energy supply of man resisting elemental forces, and the growing possibilities of transforming the environment, provide grounds for optimistic forecasts of humanity's future. An optimistic idea of the boundless possibilities of the man of the future when he achieves a harmonious interaction with the environment is justified by many of the tenets of the philosophy of dialectical materialism.

At the same time negative tendencies have also made their appearance in recent times, namely a deterioration of man's natural habitat through the effect of his own activity. The depletion of natural resources, and in particular their exploitation for the sake of gain, a rapacious attitude to nature (especially to the resources of colonial and dependent countries, and to the wealth of the world ocean), the destruction of certain species of animals and plants, soil erosion, and so on, cannot help causing alarm for the future of coming generations.

The finiteness of many kinds of resource and factors of the environment is looming before us with full clarity. Certain universal 'no man's' resources that seemed to cost nothing (for example, fresh water and air) are beginning to call for the application of more and more labour and material outlays in order to cultivate them. A 'reversal' of the finite and the infinite is taking place, as it were. A tendency toward unlimited growth of the earlier seemingly insignificant 'finite' wastes of industry is developing, and to prevent their harmful effects radical, expensive measures are needed that will lead in the end to optimisation of the whole process of man's exploitation of nature.

Optimum mastery of nature includes the cultivating of natural resources as a *sine qua non*. That applies in the main to renewable natural resources like fresh water, the biological wealth of continents and oceans, forests, soil, and atmospheric oxygen. These resources are characterised not only by total volume but also by continuously maintained balance or ratio between expenditure and natural re-creation.

Almost all types of renewable natural wealth are being used today, and the scale of the exploitation of each of them is more and more approaching the magnitude of the 'income' side of their balance. More than two-thirds of the land suitable for agricultural production, for instance, is now being cultivated, around half of the annual growth of forests is being used, and a substantial part (around 70 per cent) of the increment of the main commercial fishes.

Man's needs for renewable natural resources are growing and the means for assimilating them are becoming more and more efficient. Quite soon, therefore, we shall attain full exploitation of the 'income' side of the balance for each of them.

Furthermore, as the experience already available indicates, we shall be faced with curtailing the extraction or recovery of natural resources (as has happened, for example, in whaling) or we shall have to strike a balance between the increment and decrease of resources, or else give over to cultivating natural resources, i.e. to transforming their balances.

The obvious finiteness of the biosphere's renewable resources is a fundamental fact both of modern scientific theory and of production practice. In the future there will probably be no use values without some kind of outlay of labour.

the 'free' gifts of nature of the past will more and more become recultivated or recycled products of labour and not its natural prerequisites. Such a seemingly natural function as breathing may require preliminary outlays of labour to re-create air fit for humans (After all, it is no accident that a thing like the 'Tokyo phenomenon' has developed, i.e. the installation of automatic machines to vend fresh air, on the principle 'Pay if you want to breathe') Such re-creation of factors of the biosphere, however, is in itself also finite, the installation to purify air of course requires additional outlays of power, the production of which leads to still further pollution of the biosphere. We get a vicious technological circle, the way out of which is the subject of our subsequent analysis.

Continuing our survey of the problem of the interpenetration of the finite and the infinite in the 'man/biosphere' system, we must say that it comes up to some extent against the conservation laws that have been established for closed systems.

Optimum solution of the problem of waste disposal thus runs into the conservation laws; in a closed system any form of waste disposal will somehow or other inject them into a natural process. The concept of a closed system, besides, is itself variable and relative. What is seen today as occurring outside a certain closed system may prove tomorrow to be an internal element of some broader supra-system. One of the paradoxes of saturation can be called the 'tall chimney phenomenon'. By emitting wastes higher up where the wind speed is higher, we successfully remove them from the limits of a city, but after saturation of the whole atmosphere with this kind of waste, the height of the chimney proves un-

important in the broader closed system the laws of the conservation of wastes will operate all the same, so that more radical means of combating wastes will be needed (chemical biological purification installations, etc.). We cannot avoid new experience of the relation with nature in the epoch of the scientific and industrial revolution.

In the light of this experience an essential limitation of human activity is the following that which, in today's practice, is considered a sphere going beyond the limits of finite experience, i.e. as infinite, may tomorrow be part of the finite experience of science and technology. Those elements that are beyond the limits of our experience's finite field of application today, may come into a closed system of a higher order tomorrow that will serve as the basis of the science and technology of the future. The concept of the biosphere as the sphere of the living is itself, besides, being broadened and generalized. It is already not simply from the outer envelopes of the Earth but also from circumterrestrial space and ever deeper regions of the planet that the raw material resources needed for man's further development will be drawn. The spatial extension of the sphere of human activity governs the whole contradictory nature of the interaction of the finite and infinite. This is manifested during fundamental study of the whole diversity of our planet's connections with the Sun.

The large-scale 'Sun-atmosphere' experimental carried out in the USSR in October 1971 is of interest in that connection. During it meteorological rockets were launched from the 'Volgograd' rocket-probe station. Rockets were launched simultaneously from the Druzhnaya Observatory (on Franz Josef Land).

At the same time the atmosphere was probed by radio and meteorological sondes were released observations were carried out by the USSR Academy of Sciences' atmospheric, magnetic, and other stations and observatories.

The first series of weather rocket launchings and the part of the land observations connected with them were made immediately after the recording of a flare on the Sun while the terrestrial atmosphere was still quiet. A second series of launchings was made as soon as the Earth's magnetic field was perturbed. A third series of rockets was launched during the magnetic storm associated with ionization of the atmosphere by the corpuscular particles generated by the solar flare.

The flux of these particles the tonic composition electron concentration and density of the atmosphere pressure variations the wind regime, and the rate of photochemical reactions at all heights of the atmosphere were all registered and recorded.

The Sun's effect on the atmosphere is an experimental fact. It has to be allowed for when activity is optimised. To go further still, the question arises whether some of the particles reach the lithosphere.

But if some particles associated with the Sun reach the lithosphere there should be a solar influence on geodynamics, etc. So the concept of the biosphere as the sphere associated with life is itself generalised. It is already not simply the outer envelopes of the Earth but also circum-terrestrial space and ever deeper regions of the planet. The biosphere, as a region of reality depending on the development of life and at the same time affecting the character of that development, is proving to be an expanding suprasystem, the closed nature of which can only be

interpreted in a very relative sense. In this connection the expanding super-system of the Universe is not self-regulating; it needs, for example, a constant inflow of energy from outside from our star the Sun.

One of the present-day aspects of the finite and subject/object relation is that we are compelled to relate to resources of nature that yesterday still seemed infinite (like water and air) to finite ones, and at the same time we have to take into account that wastes that yesterday still seemed finite and insignificant may be involved in an infinite number of connections, giving rise to unexpected, and often undesirable consequences.

While the category of the finite, which is becoming the master one at this turn in the spiral of apprehending the future, is now coming to the foreground in man's practical, consumer attitude to the environment, that does not mean at all that the importance of the category of the infinite is not coming out in other aspects in man's theoretical, forecasting attitude to the environment, for instance, we come face to face with the infinite from the angle of the consequences of technogenic effects. These consequences are becoming intertwined before our eyes with an infinite number of dependences of nature in an infinite set of relations with which we must interact, while possessing finite quantities of matter, energy, and information.

That includes what can be designated as the contradiction and unity of the finite and infinite aspects of human activity. For each act of concrete, historical overcoming of this contradiction, the difference between, and at the same time the coincidence of, the finite and the infinite serves as the methodological basis.

strategic line is clear: to carry on activity in exact
accord with the conditions of the environment. That will not, of course, create extreme infinite power, but it will fully realize the great
able human power.

An important methodological instrument for
analysing the situation being created is the ex-
plicable experience of the world materialist tradi-
tion, which takes into account, as Lenin wrote
that

in his practical activity, man is confronted
with the objective world, is dependent on
it, and determines his activity by it.¹

Man was born in the process of nature's evolu-
tion as the highest product of that evolution. In
his note 'Historical' in *Dialectics of Nature*, Engels
feelingly stressed that:

The old teleology has gone to the devil, but
the certainty now stands firm that matter
in its eternal cycle moves according to
laws, which at a definite stage—now here
now there—necessarily gives rise to the
thinking mind in organic beings.²

The essential difficulty in dealing with mod-
ern problems of the environment is the appear-
ance of elements of an anti-anthropic develop-
ment of the biosphere in its, on the whole, pro-
anthropic development. That, however, by no
means signifies a fatally irreversible sliding to
worst ecological catastrophes. Man remains on
the whole master of the situation and is capable

¹ V. I. Lenin: *Complete Collected Works*, Vol. 26 (Philosophy of the Biosphere). Progress Publishers, Moscow, 1950, pp. 145 ff.

² Frederick Engels: *Notebook of Nature*. Translated and edited by Clarence Darrow with a preface and notes by J. R. & Haldane. P. P. & G. Lawrence & W. Ltd., London, 1937, p. 167.

provided certain conditions are observed, of achieving relative harmony in his inter relations with the environment (absolute harmony being, of course, an illusion)

22 THE PROBLEM OF PERMANENT CHANGE

A certain partial break in the biosphere, which is being widened more and more by irrational development of technology, is now being observed on the surface of planetaria. The scale of the break is a matter of dispute, because (as Heinrich Heine remarked) a crack in a bell is known only from the sound. The sounds coming now to a few sensitive ears from the biosphere are in a quite minor key. In general it is not difficult to see the negative shifts in the biosphere that are beginning to show and to forecast their future catastrophic dimensions. It is much more difficult to find ways of getting out of the possible (but not a bit necessary) ecological blind alleys of developing civilisation.

With a hypothetical analysis it is hard to avoid the temptation of suggesting, as a methodological prescription, a halting of movement since its negative direction is coming to light. In the work of Dennis L. Meadows and his associates (*The Limits to Growth*), this state, designed to ensure the halting of undesirable movement in the biosphere, has been given a special name—"The State of Global Equilibrium".

The conception of unchangeability of the environment, however does not stand up to

¹ Donella H. Meadows, Dennis L. Meadows, Jorgen Randers, William W. Behrens III, *The Limits to Growth*, Universe Books, New York, 1972, p. 156.

methodological criticism and in the practical sense is utopian. For man's material activity in the labour process, as we know, consists in changing natural factors. Karl Marx defined labour as the whole, in *Capital*, as

a process in which both man and Nature participate, and in which man of his own accord starts, regulates, and controls the material re-actions between himself and Nature!

Labour is the expression of man's essential forces, and to stop changing nature would mean to stop people from living. In the discussions of recent years, it is true, it has sometimes been suggested that the contemporary ecological situation allegedly gives grounds for reviewing Marxism's truisms about man as substance and labour as the form of his existence. But no 'review' or 'reconsideration' can refute the thesis about labour as man's re-action with nature and the fundamental conclusion that men exist only through altering nature. For man, to exist means to change nature. In doing so 'he opposes himself to Nature as one of her own forces'.¹

Thus, two basic elements—man and nature, linked by mediating labour—form a 'biology-like' system that functions through a mechanism of metabolism or exchange of matter.

The monistic conception regards the natural environment not as something external in regard to man (an envelope of activity), but as an inner condition of the development of a supra-system ('society/nature'), and as an inalienable ele-

¹ Karl Marx, *Capital*, Vol. I, Translated by S. Moore and E. Avreling (Progress Publishers, Moscow, 1971), p. 173.

² *Ibid.*

ment of it. The biosphere, as an ultracomplex dynamic system, emerges as an aggregate of interacting parameters of a biogenic, abiogenic, and social character.

The monistic approach to the biosphere posits, in the first place, a relatively harmonious combination of these parameters such as would enable the whole 'man/nature' system to maintain its existence. It also has to take into account, besides, the novel feature of the ecological situation caused by the fact that man, as the subject of change, is beginning considerably to transcend the conservative forces of nature directed to maintaining this system. The problem, consequently, is how man, while remaining the subject of change of the 'man/nature' system, could supplement the conservation elements proper to nature, but inadequate, by his own activity. The ecological problem is a tangle of contradictions, and its solution does not boil down to wishing for constancy in nature.

Interpretation of environmental protection as constancy of the latter is as unwarranted as the formula of the taming of nature, with its voluntaristic tones. If we orientated ourselves in practice on the immutability of nature it would be no less harmful than the destruction of nature, cases of which are, alas, only too frequent in our day.

As for the pseudo-idea of the immutability of nature and alleged illegitimacy of its alteration by man, Hegel's apt comment is very just:

In our reflection-rich and reasoned time, he who does not know how to provide good grounds for everything, even the worst and most perverted, is bound still not to go far. Everything that has become tainted in the

world has become tainted on good ground.¹ The methodological essence of the concept of defence of nature as its immutability entails in a dualistic break between man changing nature and nature itself.

The monistic conception of the biosphere, on the contrary, is based on the unity of change and conservation (or 'permanent change'). The necessity for mutable conservation or permanent change in the man/nature system stems from the universal law of the unity of being and not being. Although any system may move toward not being, the man/nature system can be prolonged in time. It is the job of science to do just that, functioning as man's defence mechanism in the struggle with a hostile and measuring environment. In that sense it has been compared with a tortoise's shell. But whereas the tortoise's shell is static, man's science is dynamic. As it has developed it has indicated ever more effective ways of changing nature. Now, indeed, it is necessary to seek no less effective ways, with science's aid, of preserving the environment as a condition of preserving man himself.

Realisation of permanent change calls for mutual adaptation of the biosphere's human and natural factors. It is important, besides, to remember that the adaptive potentials of man's biological and psychic structure are very, very limited while the adaptive possibilities of his activity are exceptionally great. By changing their activity men can in principle perfect their so-

¹ G. W. F. Hegel *Encyclopaedie der philosophischen Wissenschaften in Grundsätzen. Werke*, Vol. 6 (Duncker und Humblot, Berlin, 1840), p. 249.

cial organisation' without departing from the limits set during the long evolution of the biosphere's main parameters. In that sense a biological analogy based on Ashby's well known definition is perhaps legitimate: 'a form of behaviour is adaptive if it maintains the essential variables within physiological limits'.²

A philosophical survey of the present-day ecological situation makes it possible to conclude that a form of social scientific and technical activity is adaptive if it keeps the essential variables of the biosphere within ecological limits. How essential these variables are, and what are the ecological limits of their change, have to be explained as fully as possible by modern science. As for the practical implementation of its recommendations, that depends first and foremost on the concrete, historical circumstances and on the socio-political possibilities. The whole problem of permanent change thus acquires a comprehensive social and natural scientific character.

The solution of problems of ecological adaptation can be based, to some extent, on the experience accumulated by mechanics and the theory of the stability of motion,³ which allow:

² The interpretation of society as an adaptive system in connection with the ecological problem was substantiated by T. Markarishvili in his paper on ecological knowledge and the problem of establishing the specific nature of human society as an adaptive system in the symposium *Budashvilegi saats: Ekoleskola i ekologiya* (Tbilisi 1974).

³ R. H. Busey: *Design for a Brain. The Origin of Adaptive Behaviour* (Chapman & Hall, London 1969), p. 38.

⁴ The mathematical theory of the stability of the mechanical motion was developed in 1892 in A. Lyapunov's book *Osnovy teorii ustoychivosti dvizheniya* (*The General Stability of Motion Problem*).

to formulate the task of stability of the dynamics of the man/nature system. Februg: adaptation emerges as an indispensable condition of the stability of social motion. And although the mechanism of this motion is governed primarily by the laws of social development it is important to remember that these laws themselves are a superstructure on the biological properties of animate matter. The laws of social development do not, therefore, contradict the laws of animate matter.

The stability of the animate's development is determined by its three fundamental properties: (1) its openness, i.e. its capacity to enter into flexible relations with the environment and to create temporary combinations with bits of the environment; (2) its surmounting of the transitoriness of individual systems through the mechanism of reproduction and inheritance; (3) the cyclic nature of its development. The third property has special methodological value for carrying out programmes of lasting motion of the 'man/nature' system. The inanimate is also characterised by cyclicity in its evolution, but this property is fundamental for the animate. In the inanimate, not-being appears as the negation of being; in the sphere of the animate death is not only the negation of the individual life but is also a condition for stability of development of the whole animate sphere. Humus, for example, is a product of death but is at the same time the basis and a condition of the life of plants.

The biological cycle acts as a material guarantee of man's unceasing development as a social being. But this development has a supra-biological character. Social progress, the perfecting of individuals, and increase of their spiritual

health by no means require biological modification of man's genetic structure. Social progress is unthinkable, of course, without labour, and labour is change of the natural environment; society's progress is consequently impossible without alteration of nature. But it is important to remember two circumstances in this connection: (1) man is capable in principle, at least for the foreseeable future, of making these changes rationally, and not excessively; and (2) the transformations of the biosphere caused by technical progress include a certain invariant factor. This invariant is seemingly also a criterion of the rationality of the Ego and of the stability of the whole biosphere's development in the conditions of the scientific and industrial revolution's ever-mounting processes.

What is the criterion of stability of the biosphere's development, the invariant factor of biospheric change?

Conservation of man's bodily and mental structure. Man, as the highest embodiment of matter, is 'adjusted' by life's long evolution to its development (Sergei Vavilov said the eye was a product of the Sun).

A shift in the parameters of the bodily and mental structure through the effect of some technicised supermutation would not only be evidence of degradation of the environment but would also mean mankind's self-negation through total negation of the biosphere by scientific and technical development.

The environment's conditions can be altered somehow or other, and they can be, and have to be, manipulated; but bodily and psychic organisation (especially at the level of the gene mechanism) cannot be altered at all significantly. This set of ideas, in which the permanence of

man's structure acts as the determining criterion of the development of the 'man/nature' relations, may be called 'homofundamentalist'. Lasting change of nature is thus also change which man's bodily and psychic structure is preserved through steady increase in its information content: where man's bodily and psychic structure is constant but his information content tends to infinity.

Definite imperfections reinforced in the course of evolution are also inherent, of course, in man's bodily organisation.

Linus Pauling has stressed, for example, the a form of life like red bread mould (*Neurospora*) carries out chemical reactions in its cell that the human organism is unable to carry out with the result that it (the mould) can live in a very simple medium. *Neurospora* itself synthesises the substances it needs from a limited number of factors of its environment.¹ Man, however, needs a medium (environment) immeasurably richer in chemical substances than he can obtain in ready-made form. In the course of anthropogenesis, a manifestation of the process has been that a variety of forms of food containing chemical substances needed for life became available to man's ancestors, and later to man himself. Through that man's ancestors simplified 'their own biochemical lives by shuffling off the machinery that had been needed by their ancestors for synthesising these substances'.²

Loss of the capacity to synthesise essential substances was also the product of a certain pro-

¹ Linus Pauling, *Vitamin C and the Common Cold* (Freeman & Co., San Francisco, 1970), p. 51.

² *Ibid.*, pp. 55-57.

ess (man became able to obtain them from the environment) and at the same time a condition of further perfecting of man's bodily structure.

On that level a very important law of progressive evolution may be formulated as follows: as a biological species' capability of obtaining food improves it loses the capacity to synthesise essential substances. This law clearly expresses the contradiction between the unity of the perfection and imperfection of a species that can be defined as evolutionary relativism (perfection in one aspect is always accompanied with imperfection in another). The mechanism of animate matter's progressive evolution is thus paradoxical: the higher a species' domination of the environment (the more perfect its means of obtaining food), the greater is its dependence on the environment because of loss of the ability to synthesise a number of (but not, of course, all) essential substances.

Linus Pauling considered this contradiction in Vitamin C and the Common Cold on the example of loss of the ability to synthesise ascorbic acid by the common ancestor of the primates (as the consequence of a mutation that happened roughly 25 million years ago).¹

In that connection he wrote:

We are accustomed to thinking of man as the highest of all species of living organisms. In one sense he is; he has achieved effective control over a large part of the earth, and has even begun to extend his realm as far as the moon. But in his biochemical capabilities he is inferior to many other organisms, including even unicel-

¹ Ibid., p. 58.

value organisms such as forests, grass and meadows.

At the same time man has achieved a strong biological and physiognomical effect on this: it is necessary to preserve for as long as possible.

Methodologically speaking an important condition for stability of the dynamics of the nature system is the element of the relative circular cyclic character of the evolution of the biosphere itself, and the relationship of its own active and inactionary factors. In particular, the inactionary factor should display its force in the search for more rational ways of transforming the biosphere and ways out of blind alley situations. If Khilmi names the following¹ the three main factors of resistance among living systems: (1) degradation of energy; (2) degradation of the organised structure of a living system taken on its own, the fate of which is dissolution in the environment (medium); (3) the irregularity of the inflow of free energy. Mankind, possessing reason (expressed in scientific and rational actions), can overcome the second and third factors in corresponding social conditions, and weaken the effect of the first for many years.

Circular cyclicity is a practical way of overcoming the seeming theoretically irresolvable conflict of the finite and the infinite. Williams' thesis that the 'sole means of lending a limited quantity the property of infinity is to force it to revolve in a closed curve'²

The improving of a struggle depends on the strength of the opponent. Just as the pike's transparency is the main condition for the carp's

¹ Linus Pauling *Op. cit.*, p. 54.

² V. Williams. Agronomy. *Sobraniye sochinenij* Vol. 10, (AN SSSR, Moscow, 1952), p. 11.

wakefulness, so the environment's resistance acts as a constant reason for improvement of human activity. A fabulous environment flowing with milk and honey is more dangerous than one with smog, because in the first man's degradation as a lotus-eater (eater of free benefits) would be inevitable. The circular cycle (resistance of the environment—the overcoming of that resistance—new resistance of the environment—again its overcoming) is not a regrettable disturbance of the tenor of human existence but, on the contrary, the inner spring of its development.

Circular cyclicity of movement comes into conflict with the prevailing tendency of irreversibility. At the level of the animate and the biosphere as a whole this conflict finds effective resolution so long as the biosphere receives an adequate quantity of the convertible energy by whose irreplaceable expenditure we live.

The circular cyclicity of development is always, of course, transitory, temporary, relative. The irreversibility of the development process, in the final analysis, is absolute. In our earthly conditions irreversibility is based on the irreversibility of the energy processes taking place in the interior of our star, the Sun (the burning up of hydrogen, the main energy resource of the Solar system, is irreversible).

It is impossible in general to prevent irreversibility but, by knowing how to control cyclic processes, degradational, destructive tendencies can be overcome for quite a long time and quite effectively.

The monistic conception of the biosphere as a conception of lasting change is based on the dialectical unity of reversibility and irreversibility.

The factor of reversibility inherent in man's phenomena, it goes without saying, cannot be carried over in vulgarised fashion into social progress and its irreversible sphere, technical development. The capitalist system's incapacity to resolve the ecological problem optimally, nationally, and consistently enough has given rise to a kind of 'anti-science' extremism. The 'back to nature' slogan, Orientomania (idealisation of the oriental world's closeness to nature), the pressing of rejection of technical achievements—such are the fruits of the ecological maladjustment of the West's consciousness. Jean Dorst, for instance, calls on man, in emotional despair, to find his place in the living world that he thought he could escape from by his technical genius.¹ That, he says, is the humanist position. But in a world in which there is still so much brutality and poverty, calls like that for the civilising of man are most irrational. Such a cycle—from the uncivilised state through technique again to existence without technology—would be a catastrophe for men, its realisation is associated solely with the consequences of global thermonuclear war. Mankind's peaceful development, however, will take the road of reversible scientific and technical progress. The now existing but quite avertible threat of universal nuclear catastrophe linked with the continuing arms race, is even perceived by Dorst optimistically, but in a reactionary, utopian spirit:

The histories of the future will then describe the technical civilisation of the twentieth century.

¹ Jean Dorst, *Arrest que Nature m'aure* (Delachaux et Niestlé, Neuchâtel, Suisse, 1957), p. 37.

tieth century as a monstrous cancer that nearly dragged man to total ruin¹

The views of reactionary, utopian romanticism are seemingly ineradicable while class, antagonistic relations exist. Trusting in the past is the lot of those who are discontented with social progress and defeated by it Marx wrote, in particular:

The first reaction against the French Revolution and the period of Enlightenment bound up with it was naturally to regard everything mediaeval as romantic²

Moods of a return are, of course, foreign to the Marxist outlook on the world. The job is to achieve a stable relationship with the nature of man's living, technical development. Because it is planned technical development under the appropriate social conditions that creates the truly real basis of social progress, the real basis for perfecting of the working individual.

Man and the Second Law of Thermodynamics³ or Rational Anthropocentrism— 'Homo/fundamentalism'

Nature's engendering of man in the course of evolution provides the key moment for understanding their interrelation as thinking and non-thinking material formations.

The fundamental peculiarity of life as objective reality is linked in turn with its anti-chanceogenic character. As Khilmi says, life emerges

¹ *Ibid.*, p. 401

² Karl Marx Letter to Engels of 25 March 1868
In: Karl Marx and Frederick Engels *Selected Correspondence* (Martin Lawrence, London, 1934), p. 225

³ The natural law that says that the entropy of a closed system increases with time

clarifying the links between thermodynamics and the theory of life. Khil'mi concluded:

The results of analysing living systems as energy-harvesting systems, combined with those of analysing living systems' relations with the environment, can be formulated as follows. The resistance of the environment caused by the second law of thermodynamics, the law of organic degradation,² and the irregularity of the flow of free energy, i.e. at the same time an obstacle surmountable by living sys-

¹ G. F. Khil'mi. The Organisation of the Biosphere and the Cosmic Tendency to Chaos. In: I. P. Geninov (Ed.) *Rossiyanskaya biosfera na territorii SSSR* (Nauka, Moscow, 1971), p. 42.

² This is Khil'mi's term for the medium in which the degradation of energy and of organised structure occurs, and the flow of free energy is variable (*ibid.*, p. 42). —Tr.

³ I.e. degradation of the organised structure of material systems (*ibid.*, p. 38). —Tr.

tures and a *sine qua non* for the genesis, existence, and development of organisms¹

The anti-entropy nature of life is its cardinal physical characteristic. As Khilmi writes,

The chaotogenic medium regularly engenders its dialectical negation, i.e. living systems that overcome the chaotogenic character of the Universe.²

At the level of the living, however, this overcoming has a latent undeveloped character, for the living organises itself solely through adaptation to the environment, and in the final analysis any living system is subordinated to the environment. The anti-entropy character of life is fully displayed only at the level of conscious living systems capable of adapting the environment to their needs and interests. More and more man's comprehensible needs become the regulator of both human activity and its effect on the environment. As the productive forces grow, moreover, these needs become more and more refined and mediated in relation to their initial biological basis, i.e. need for food and shelter. 'The field of needs' acquires a certain independence, as it were, in relation to its 'charge', i.e. to man's bodily and psychic structure. This field develops sometimes by irrational laws. In the last century, for instance, people began to extract oil mainly for kerosine for illumination. The light fractions (petrol) were burnt as waste.

At every step in the history of civilisation what originally seemed waste became a valuable product with the advance of knowledge, and the previously valuable product was depre-

¹ *Ibid.*, p. 43

² *Ibid.*, p. 45

ciated On destroying some finite resource of the planet men have discovered new paths of technology using new resources (in practice infinite for the time).

In those cases when victory of the finite and the limited over the infinite and the unlimited seemed inevitable, an enigmatic 'ingenuity of the mind' operated, enabling men to move steadily, in overcoming every crisis, along the line of improvement and progress.

The existence of reason naturally functions as some compensatory mechanism associated with the physical structure of our world. On the physical plane it functions as a mechanism of the search for convertible energy; by virtue of that, such a mechanism would be superfluous in a world of undegraded energy and an intelligent creature could not originate. Hence it also follows that man is consequently a product of the second law of thermodynamics, i.e. of the natural law that says that energy depreciates with time.

In the last century entropy was called (and justly!) the 'empress' of the world. We might add that it is also the 'great-grandmother of man'. In the last century's discussions on the nature of entropy, Maxwell had put forward the idea of a 'demon' capable of separating molecules by velocity and so creating and re-creating a temperature gradient as the real basis for obtaining free energy.

Even before Maxwell, Loschmidt had postulated tiny rational creatures capable of differentiating molecules and dividing them by velocities. Boltzmann, recalling his discussions with Loschmidt, wrote:

But even then I would not admit it (the appearance of Maxwell's demons—*J. N.*)

and opposed to it that when all temperature differences had come to an end, no intelligent creatures could arise either. No intelligence, I said, could exist in a cellar with a uniform temperature throughout it.¹

The Austrian physicist Josef Stefan, who was patiently listening to this dispute, exclaimed: 'Now I know why your experiments with big glass tubes in the cellar failed so lamentably'.² The fact was that to test the second law of thermodynamics, Loschmidt had set up three enormous glass tubes with a salt solution in the cellar of the Physics Institute of Vienna University. The idea had been to test whether the difference in concentration of the upper and lower layers of the solution would alter in time; it was calculated, however, that it would be necessary to wait 3000 years.

Quite understandably, 'ingenuity of the mind' oriented on the quickest possible effect is particularly characteristic of the capitalist stage of history. As Karl Marx wrote:

For the first time, nature becomes purely an object for humankind, purely a matter of utility; ceases to be recognized as a power for itself; and the theoretical discovery of its autonomous laws appears merely as a ruse so as to subjugate it under human needs, whether as an object of consumption or as a means of production (My italics—I. N.).³

¹ L. Boltzmann *Populäre Schriften* (Verlag Barth, Leipzig, 1925), p. 231.

² *Ibid*.

³ Karl Marx *Grundrisse* *Introduction to the Critique of Political Economy* Translated by Martin Nicolaus (Penguin Books, Harmondsworth, 1973), p. 410.

Under socialism men vanquish nature by reason, achieving a harmonious relationship between human consumption and the mechanism of the functioning of nature.

Given social relations based on property belonging to the whole people full development of a humanist programme is obtained that puts man at the focus and subordinates resolution of the ecological problems to his interests as well.

The monistic approach to analysing the ecological problem leads to the idea of a rationally interpreted moment of anthropocentrism, which we designate as homofundamentalism, making man the cornerstone.

Man is the bearer of the motif of knowledge and the goal of the whole cognitive process, i.e. the conception of man proves to be the foundation of all the scientific reasons that we also call homofundamentalism, which is acquiring exceptional significance under the scientific and industrial revolution.

Before ideas about homofundamentalism develop, it is necessary, quite understandably, to disclose their whole opposition to the outlook of theological and subjective idealist anthropocentrism. These fundamental distinctions have to be distinguished.

1 In the Christian religion the creation of man by God (i.e. the miraculous and extra-natural) proves to be the supreme justification of irrational anthropocentrism.

Peter the Lombard wrote in his 'Sentences':
Just as man is made for the sake of God—that is, that he may serve Him, as the universe is made for the sake of man—that is, that it may serve him; therefore is man placed at the middle point of the universe, that he may both serve

(God I N) and be served (by the creatures of Nature I N).¹

Man's central position in any form of irrational theological anthropocentrism is consequently not fundamentally mediated by his involvement in God, but derivatively. Man is not the lord but the vessel who rules in his estate on earth 'by the power of attorney' of a superhuman being.

The very posing of the question of the purposes for which men are created, moreover, of course turns out to be teleological extreme. The purpose, not of the natural process, but of human activity as a process, is man himself. And the question of the 'final purpose' ('what does humanity exist for?') is frankly speaking meaningless.

In contrast to theology man is the centre for materialism (not, of course of the world, but of a cognitive practical relation to the world) through himself, and precisely of his rationally active essence and his social links with other people. Man is the axiological centre of all reality because he is the highest value and relatively stable system of reference thanks to which we can also evaluate movement, i.e. change in general as progress or regression.

In the struggle against subjectivism we lay natural stress on objectivity, but it is sometimes overdone into a dehumanising of science. A great human rehabilitation of science and an abrupt turn of knowledge toward man are now under way. That stresses the fundamental na-

¹ Cited from A. D. White, *A History of the Warfare of Science with Theology in Christendom*, Vol. 1 (Dover Publications, New York, 1960), p. 117. (My italics.—I. N.)

ture of man (as an aggregate of social relations) for all modern science.

2 Man appears in subjective anthropocentrism (going back to Berkeleyism) as a 'soliloquy piano', to use Diderot's phrase¹, that thinks that it alone contains all the harmony of the universe. Man's central position is ensured in subjective idealism at the price of losing the subject's connection with the real world, by denying the reality of this world, and reducing it to an aggregate of sensations. The most irrational type of this variant of anthropocentrism is solipsism, which denies the real existence of all other people. In contrast to it materialist homofundamentalism posits maximum penetration of the object by the subject for the given concrete historical conditions and maximum convergence of the subject and the external real world.

3. Irrational anthropocentrism is passively contemplative and orients man on submergence in himself and inactivity. It endeavours, especially in its oriental Buddhist variant, to demonstrate the unecessariness of action, the unecessariness of transforming that which is outside you because you are it. The irrational dissolution of man in nature is the other side of the medal of anthropocentrism.

In rational conceptions, in contrast to irrational contemplative anthropocentrism, contemplation itself is interpreted as activity differing radically from ordinary mundane activity not in its subject matter (it can also be directed to the external world) but in its aim (it lacks the pragmatic context of an attitude to the world). In the *Nicomachian Ethics* Aristotle wrote:

¹ Cited from V. I. Lenin. Materialism and Empirio-Criticism. Collected Works, Vol. 14 (Progress Publishers, Moscow, 1968), p. 33.

but the Working of the Intellect, being apt for contemplation, is thought to excel in earnestness, and to aim at no End beyond itself, and to have pleasure of its own which helps to increase the Working, and if the attributes of Self Sufficiency, and capacity of rest, and unweariness (as far as is computable with the infirmity of human nature), and all other attributes of the highest Happiness¹

The highest type of this contemplative leisure or capacity of rest is philosophy itself, all concepts of truth and good, and everything counterposed to huckstering practice. It was not without reason that in Raphael's picture *The Lyceum* Aristotle is not only pointing to the earth with one hand (unlike Plato, who is pointing to heaven), but is also holding the *Ethics* in the other.

We can thus conclude that whereas irrational anthropocentrism substantiates inactivity by theological assumptions (why act if everything in the world is predestined by God to serve man), rational homofundamentalism is the philosophy of real activity (to act so that man himself would be the aim).

It is the individual taken separately at the highest value ('everything for the sake of man, for the benefit of man', as it is written in the Programme of the Communist Party of the Soviet Union), who emerges as the basis of all other evaluations. That, moreover, is the methodological, axiological scale, in contrast to ontological anthropocentrism, which inevitably arrives at the positions of theology and telenology.

¹ Aristotle *The Ethics of Aristotle*. Introduction by J. A. Smith. Translated by D. P. Chase, (New York, London, Dent), 1950, p. 28.

We measure all the rest of the world by man, therefore, because it is so undesirable to make essential mistakes in this standard, caution is needed in characterising any changes in man's bodily and psychic structure.

In the light of the homofundamentalist conception harmonisation of man's interaction with nature posits both a desirous reorganisation of science and a radical change in activity. In that sense optimisation of the biosphere emerges in our time (when the whole environment is 'worked on', i.e. subjected to man's action) above all as optimisation of human activity. Less and less of 'primaeva' nature remains before us and the natural environment is becoming more and more 'humanised'. Man is, as it were, shaping the environment of his own habitat and is becoming, as it were, a consequence of his activities, 'his own environment'. And indeed, the environment of a given generation of people is largely the products and results of the activity of preceding generations.

We call surveying of the processes of objective reality and the ways of cognising them from the angle of human activity the actiological approach (from *actio*)¹.

Khilmi stresses that the scientific theory of the biosphere includes five mutually supplementing conceptions of same, i.e. the geochemical, geocoenological, thermodynamic, geophysical, and socio-ecological.²

¹ I. B. Novik. Some Aspects of the Interaction of Geography and the Natural Sciences. *Voprosy Filosofii*, 1, 9 (1971).

² I. F. Khilmi. Modern Conceptions of the Biosphere. I. B. Novik et al. (Eds.), *Metodologicheskie i istoriko-kriticheskiye issledovaniya biosfery* (Nauka, Moscow, 1973), 21 (1973).

It seems useful to add yet another aspect to that list of the elements of an integral theory of the biosphere, namely, an ecological conception of the biosphere that could perform a definite methodological role as regards all approaches to the environment from the angle of the special sciences.

In the general description of human activity as a process of natural history taking place through objective laws connected with the subject's consciousness and will, an approach from the angle of entropy is essential. According to that conception, a certain finite system can not increase its entropy in the course of some finite period of time, and even lower it, simply by increasing the entropy of the surrounding medium. In relation to the species *Homo sapiens* this approach means that man is achieving progressive improvement solely by introducing regressive and chaotic elements into the environment.

Absolutising of this approach sometimes leads writers abroad to the idea of man's parasitic essence in relation to nature. Jean Dorst, for instance, compares man with 'a maggot in a fruit', or 'a moth in a ball of wool', gnawing away 'at his habitat, while exuding theories to justify his action'.¹ The attempt to construct some conception of 'nature versus man' leads to a kind of deifying of nature. Only one point of view is legitimate in the relationship of man and nature, namely the point of view of man himself. The stand of 'nature's bill presented to man' is illusory. The legitimate approach is the homofundamental one, i.e. the approach to this relationship solely from the standpoint of man.

¹ Jean Dorst, *Op. cit.*, p. 520.

and his interests. But that position must be rational, optimised on the plane of a certain reorganisation and directed at the nature of human activity.

Not only is the conception of man's parasitism on nature unwarranted, in our view, so, too, is the opposite conception of his superglobal, cosmic service to nature. It has long been known that extremes meet, and the conception of man very harmful for nature is as illusory as that of man superuseful to nature, who settles all her conflicts and antagonisms. There is objective necessity in nature but no needs. To think that nature creates man as her special organ to realise certain of her highest aims means (in our view) to pass from positions of rational fantasy to a standpoint of irrational fantasy, that is to say, in essence, to mystical fantasy. Because of that the beautiful sounding question 'Humanity—what is it for?' is completely illegitimate theoretically. Man and humanity have a purpose, and it is far from simple to realise humanity's highest purposes. But the question about humanity's ultimate purpose leads to a meaningless doubling of the problem. Posing of the question of mankind's 'ultimate purpose' ('What is mankind for?') not only does not help provide a substantiation of real human aims scientifically, but on the contrary, in our view, obscures the essence of the problem, transposing it to the plane of hopeless 'evil infinity'. With that approach an endless series is obtained, the question can be posed without stop. That is why man's ultimate purpose or 'what are the ultimate purposes of human aims', etc., lead to nonsense. In the last century the anthropological approach to man, seeing his essence in his internal corporal organisation, revealed its limit-

nature, and in our time the cosmic approach, seeing man's essence in extrahuman (universal) tasks on the boundary of the micro-, macro-, and mega-worlds, has to be classed among the infantile disorders of the space age.

At today's stage of development of science it is not the 'subhuman' or the 'extrahuman' approach to man, but the 'human' approach, that is legitimate. And that approach regards humanity as the real given entity, for which it is necessary to get the best conditions of existence and development, and without seeking a mysterious higher 'transcendent' being in it. Mankind's being itself is the basis and supreme sense for the existence both of humanity and of the separate individual.

As regards the extremes that absolutise both the negative (man as the disorganiser of nature) and the positive (man as the superorganiser of nature) moments of the inter-relation of man and nature, they (as we shall see) have common features determining their unsoundness. On the theoretical plane their common feature is the anthropomorphising of nature, saddling certain features of man's activity onto it. A kind of twentieth century mythology is thereby created of nature as god and of man as its prophet.

Let us consider what the practical consequences of these extremes are. These views are undoubtedly put forward from good humanistic motives in order to stress quite justified slogans—do not damage nature, we must allow for man's improving effect on nature. But with non-trivial absolutising these trivial maxims lead to a quite opposite effect. Here we come up against the dialectic of 'inordinate truth'. In '*Left-Wing Communism—an Infantile Disorder*' Lenin brilliantly demonstrated that any political or other

truth can be reduced to absurdity if it is 'overdone', i.e. 'carried beyond the limits of its actual applicability'')

The truth of the possibility of man's regulating effect on nature, for instance, is taken to 'extremes' when it is reduced to arguments about 'mankind as an organ of nature' and so on and so forth.

In essence, both these extremes—'man as evil for nature' and 'man the long awaited regulator of nature'—lead to a counterposing of man and nature and to a dualistic rupture between them

In the methodological, practical aspect man is at the centre in the 'man/nature' relationship, not on the plane of the mystic dogmas of religious anthropocentrism, but in the spirit of recognition of the possible rationalisation of human activity connected with nature in the interests of man himself. That is a continuation of the humanising of nature as forms of the human scale to the non-human sphere. This rational generalisation of the human in its sense is opposed to semi-mystical anthropomorphism as an unwarranted transference of man's features to nature. The methodological generalisation of the human has as its ontological basis the real community of man and nature, that must also be restored in the conditions of today's scientific and technical development which does not necessarily disorganise nature.

The deterioration and improvement of nature are terms that cannot be taken simply from the angle of the development of nature herself, their real sense is manifested in man's attitude to it.

In nature there are processes, more or less significant, but no values and no evaluations. The deterioration or improvement of nature mean above all the deterioration or improvement of men's conditions of living. Besides, the basis of a rational relationship between man and nature is, of course, not the principle of conserving the *status quo* (that is why it is presented as the limited, static formula 'protection of nature'), but the principle of the progressive development of the activity of generations of humans following one after the other. On the plane of that approach, man's attitude to nature is essentially his attitude to man extrapolated into the future. For we pass on to posterity not only scientific and technical information, towns, and works of art, but also an improved biosphere, capable of further improvement.

The problem of the environment in its rational sense is that of man, his future, and truly free development on a world scale. The whole process of actions on nature must be subordinated to man's interests and to the tasks of preserving and perfecting him.

In addition to this common criterion of optimisation of the biosphere, there is also the role of the main methodological condition of the harmonious development of man's activity. This condition is linked, as we remarked earlier, with the universality of the mechanism of change and development itself also justified for the interrelation of man and the environment in the period of the contemporary scientific and industrial revolution.

The essence of that approach is the hierarchical systematism of the inter-relation of man and the environment. Man and nature must essentially be characterised at the present high lev-

el of development of science and technique as two opposed systems (the biosphere is not a shell in which man is judged, but a certain structure of his activity), not as two automata playing a game together (in the concepts of the theory of games), but as two elements of a single supersystem. And here the important thing is not to bequeath to the next generation an intermediate summated result such as might disturb the dependence of man and nature and so interrupt the succession of human generations. In this 'homo-sociornatural' system, the decisive controlling subsystem is man and his optimizing activity and his responsibility for the fate of the whole system.

It is quite understandable that defects and even breakdowns in this ultracomplex system are largely due to errors and miscalculations in human activity. But it would be simplifying things to treat these miscalculations themselves in the spirit of the 'principle of incompetence' or 'Peter principle'. In his introduction to *The Peter Principle* Raymond Hull cited an example of professional incompetence:

Lately I read about the collapse of three giant cooling towers at a British power-station: they . . . were not strong enough to withstand a good blow of wind.'

Such grossly primitive ignoring of the real conditions of nature of course by no means exhausts the scientific essence of the problem of the 'man/nature' relationship in the decision of which science faces a number of general methodical and concrete, specific difficulties.

¹ Laurence J. Peter and Raymon Hull. *The Peter Principle. Why Things Always Go Wrong* (Wm Morrow & Co., New York, 1969), p. 9.

2.3 SCIENCE AND THE IMPOSSIBLE

Science is opening up new possibilities for increasing the effectiveness of human activity. Without it these opportunities would either remain latent in general or at best would be discovered by trial and error, but the sciences contract experience of fast flowing life for us. The idea of the transmutation of atoms would have remained unrealised if modern science had not implemented it.

In addition, in accordance with the law of dialectical contradiction, science by disclosing new possibilities, at the same time introduces a factor of impossibility as well into human activity. In the philosophical sense this impossibility emerges primarily as an attribute of objectivity. That is why reality exists outside man and independent of him, and man comes up against the impossible in his relation with the world. In practice the impossible serves as an argument in favour of the objectivity of the world and confirms the isolation of the subjective and the objective. As Lenin remarked:

Man's will, his practice, itself blocks the attainment of its end . in that it separates itself from cognition and does not recognise external actuality for that which truly is (for objective truth) ¹

In order not to come face to face against the impossible in already occurring acts, man has to construct impossible connections in his head

¹ V. I. Lenin. Conspectus of Hegel's "Science of Logic". Collected Works, Vol. 33 (Philosophical Notebooks), Progress Publishers, Moscow, 1976, p. 216

even before they begin to be materialised in practice it is that rational knowledge, science which has to separate the possible and the impossible beforehand in determining the strategy and tactics of human activity.

In order to analyse the mechanism of scientifically based separation we have to clarify the basic forms of impossibility.

The first, most universal form is impossibility by postulate. It is maximally wide, does not follow from laws, but on the contrary serves as the basis of laws. Such, for example, is the axiom of causality in the special theory of relativity: namely the impossibility of influencing the past. That form of impossibility is obviously incontestable: it cannot be got around in any way in human activity.

The second form is impossibility by law. In essence any law of nature confirming the actuality or probability of some possibility can always be formulated in another way, as a judgment of impossibility. It is impossible, for example, because of the law of universal gravitation, for a body heavier than air to be kept permanently in the air and not fall to the ground. But a heavier-than-air flying machine does not fall. The reason is obvious: it does not fall because of a 'ruse' of reason, which employs various laws and forces of nature for its own purposes. Man has not got the physical forces to fly but he flies thanks to the strength of his reason and the materialisation of ideas in the course of the labour process.

An objective law is a boundary separating the possible from the impossible. Rudolf Carnap, analysing the explanatory function of a law in his polemic against Hans Driesch's vitalist conceptions, justly stressed that a law generally

ing empirical facts or more particular laws formulated earlier provides the answer to why a given phenomenon is possible. If we do not recognise that kind of explanation at the basis of laws, we fall into an illusion of 'all possibility' (Clearly, the extreme judgment 'everything is possible in the world' is equivalent [the meeting of extremes!] of the statement 'nothing is impossible in the world')

At the same time laws are not final, once and for all dividing the possible from the impossible, because our knowledge of laws is also changing and it is not excluded that the laws themselves are mutable.

In that connection Carnap, in particular, remarked:

The actual world is a world that is constantly changing. Even the most fundamental laws of physics may, for all we can be sure, vary slightly from century to century. What we believe to be a physical constant with a fixed value may be subject to vast cyclic changes that we have not yet observed.¹

But even in abstracting the mutability of objective laws it is necessary to foresee the possible mobility of the laws of science understood as a historical process of the deepening of knowledge and having a factor of relativity in the demarcation of the possible and the impossible. That relativity is manifested even more obviously in practice. Yesterday it was impossible to transmit a two-dimensional picture over a distance, but today when we have studied

¹ Rudolf Carnap *Philosophical Foundations of Science An Introduction to the Philosophy of Science* Edited by Martin Gardner (Basic Books, New York, 1963), p. 10.

electromagnetic phenomena more fully and thoroughly, it has become possible. By applying the laws discovered by science, man extends the sphere of the possible, thereby contracting the area of the impossible. The concrete law defines impossibility as relative. This relativity of 'impossibility by laws', however, always includes an absolute element at each historical stage that does not cease to be absolute because of being mobile.

Here we come to the third form of impossibility, namely absolute impossibility.

This form has a special class of laws, the laws of impossibility. The most important of them is the second law of thermodynamics, affirming the inevitability of the degradation of energy in a closed system. In the inter-relation of man and nature we cannot avoid the limitations laid on man's activity by nature into account. And whereas, earlier, stress was laid on the relativity and historically transient character of these limitations, it is more important in today's ecological situation to put the methodological accent on the absolute factor contained in them.

Recognition of this has always been a key point of the materialist outlook in the fight against idealism and religion. Feuerbach, for example, stressed that 'the divine being is nothing else than the nature of men set free from the limits of nature.'¹

In the man/nature relationship men's activity at any sufficiently high level of technical development you like cannot in general be ridded of natural necessity. At the same time, nothing

¹ Ludwig Feuerbach, *Grundzüge der Philosophie der Zukunft (Quellen der Philosophie)* (Klostermann, Frankfurt am Main, 1917), p. 63.

In the epoch of the scientific and industrial revolution. Whereas the limitations of this necessity used to emerge as nature's uncontrollable elemental power, overwhelming weak man, it is now associated above all with the fragility of nature that unco-ordinated technical power could irreversibly disrupt, thereby wiping out the material foundation of the being of man himself.

In addition, however developed science and technology become, there will always be natural processes, some of which are not yet in general understood at a given stage, and while the mechanism of others will be revealed by science they will not yet be amenable to control.

In that connection let us consider the fourth form of impossibility, its cosmic aspect.

This aspect is linked with the internal genetic unity of evolving nature. Allowing for this unity is a methodological condition of effective organisation of man's interaction with nature in the epoch of the scientific and industrial revolution.

The sources of a philosophical understanding of the genetic-monistic approach to the 'man/nature' system are contained in Marx and Engels' thesis:

We know only a single science, the science of history. One can look at history from two sides and divide it into the history of nature and the history of men. The two sides are, however, inseparable; the history of nature and the history of men are dependent on each other so long as men exist.¹

¹ Karl Marx and Frederick Engels. *The German Ideology*. Collected Works, Vol. 5 (Progress Publishers, Moscow, 1975), p. 23.

The generic unity of the world in time is supplemented by its unity in space at any stage. In present research into the biosphere the cosmic aspect is arising in connection with the necessity to analyse and take into account the cosmic effect on the biosphere, which it is still often impossible to do today before the cosmic aspect of impossibility. It is necessary, besides, to remember the interaction as well: terrestrial factors can also, in turn, influence cosmic processes (at least within inner cosmic space) in the form, for example, of unforeseen technological contamination or the creation of artificial celestial bodies (let us recall, for example, the attractive but refuted idea of the technogenic nature of Mars' satellite).

It is this connection of the ecological problem with the interpretation of the world as a single whole that gives the present relation of man and nature profound philosophical meaning. The late M. V. Keldysh, then President of the USSR Academy of Sciences, said at a session of its Presidium:

The problem of our approach to the exploitation of nature and utilization of what nature gives us must also be a subject for philosophy and natural science and have a definite effect on the development of the natural sciences.

Attempts are being made at the present time to restore the balance in the study of nature that was rather disturbed by the effect of the rapid progress of physics and several other sciences. It is also a major problem for humanity. These questions must be discussed not only on the purely scientific level but also from

the point of view of their consequences for the development of society's affairs?

The achievements of human genius in the science age have engendered an illusion of the absolute omnipotence of knowledge. In actual fact one of the real forces of science is its capacity to rid mankind of illusions of every kind, by showing it the existence of real impossibilities. That also applies fairly to the ecological problem. Whatever heights the scientific knowledge regulating human activity attains objective reality will always be primary in relation to it.

At any arbitrarily high stage of development of science and technology men will not be able wholly to avoid the effect of natural necessity, and will not be able to leave it out of account. As Lenin said:

The 'objective world' 'pursues its own course'; and man's practice, confronted by this objective world, encounters 'obstacles in the realisation' of the End, even 'impossibility'.¹

Both the scientifically substantiated thesis of the present transformation of science into a direct productive force of society and pseudo-scientific arguments about the omnipotence of science equally need appropriate philosophical interpretation and evaluation.

If mind or spirit is made omnipotent then matter is wholly subordinated to mind. That is clearly impossible in practice for the reason that any kind of voluntaristic action turns against man. It is also impossible theoretically because we have no serious scientific argument in favour of such an approach and cannot have

¹ *Lenin At 5000, 1970* p. 48.

² V. I. Lenin, *Op. cit.*, p. 214.

The leading factor of being is objective reality which interacts either with the subject or with what the subject co-ordinates its activity. It is also wholly impossible to comprehend and to practice master all the real processes of an infinite world and all the infinitely varied forces of nature.

If, for example, we succeeded in the coming years in understanding the mechanism of earthquakes, at best we could organise a quite reliable service for predicting them but we would still be a long way from being able to prevent them (let us recall that tens of thousands of persons were killed by just the earthquake of 16 May 1970 in Peru). Later at some new stage of science's development we might obtain the means to prevent earthquakes but at the same time new natural forces would be discovered that would also be simply in the sphere of scientific knowledge but still outside the sphere of practical action.

We are becoming convinced in the space age that essentially the Earth is not separated from the surrounding system and is not a finite object for human activity. The Earth is closely linked not only with circumterrestrial space but in general with the Universe. Suggestions are now being made, for instance, about a link between earthquake and processes taking place in the Sun. It may even turn out that a radical means against coronary thromboses, for example, would be to prevent magnetic storms on the Sun or to find some kind of defence against them. In general, people are becoming more and more convinced that Earth's master is the Sun.

In short, man's scientific and technical power cannot be understood on the plane of

tion of his activity connected with the predominance in the first analysis of the moment of irreversible development.

In fact, however well organised man's intervention with nature is, it loses its stability in the course of time, goes wrong, becomes disorganized, and even passes into its opposite (the state of ecological crisis). We start, however, from the intuitive assumption that new additional action will again draw the process into the channel of a certain harmoniousness.

The basic axiom of human activity can be formulated as follows: although time is irreversible, each negative consequence of our actions may nevertheless be compensated. And in that sense the procedure of optimisation is reversible. — $C_{A_1} + A_2 \geq 0$.¹ That formula records that the negative consequences of some act ($= C_{A_1}$) may be brought to zero or even to a positive effect by the addition of another act (A_2). There is, of course, a moment of reversibility in the 'man/nature' inter-relation and it will be successfully employed by men in the future, too (restoration of forests, lakes, and soil after the mining of minerals, etc.). But it will readily be seen that the additional organising activity calls each time for an ever greater expenditure of extra energy.

On the whole, therefore, reversibility in the 'man/nature' relation is of course relative, and subordinate to the irreversibility prevailing in objective processes. That is manifested primarily in the expenditure of energy on supplementary harmonising activity constantly increasing in the

¹ The formula has the following form: the negative consequences of the first act (C_{A_1}) plus a second act (A_2) is greater than, or equal to, zero.

course of irreversible time. The energy price of undoing or compensating the harm of each step of affecting the environment is rising in one direction, but this unidirectionality does not at all call in question the possibility (with the appropriate social conditions, a sufficiency of convertible energy, and a steady extension of information) of free, progressive development of human being.

the in the environment (sometimes called the transition to an 'oriental' type of civilization). The second extreme consists in the pseudo-optimistic assumption that nature's resource and assimilative possibilities are unlimited, so that it (nature) will ultimately reach equilibrium with any possible state of technique. These extremes are presented here in exaggerated form so as to bring out more sharply the need to seek the optimum in the dynamics of the 'man/nature' system. This conception of optimisation has a profound dialectical foundation in the opposition of the concepts of nature and man; the problem is not to remove this vital contradiction absolutely but to realize the most rational (i.e. optimum) relative unity of the concepts in each concrete case.

Optimisation as social man's activity in conditions of natural limitations by no means signifies men's retreat under the external environment's onslaughts. Rousseau once wrote that although

God's power needs no method to shorten his work, it is worthy of his wisdom to prefer the simplest ways so that there will be as little useless in the means as in the results.¹

The ways of optimising the biosphere, like those of optimum co-ordination of its thinking and unthinking components, are far from simple. In order to work them out and realise them we have above all to turn to the methodology of optimising the biosphere under the scientific and industrial revolution.

¹ Jean Jacques Rousseau, *Jalle ou la nouvelle Héloise*, Paris, Garnier Frères, Libraires-Éditeurs, 2d p 586.

3.1. THE METHODOLOGY OF OPTIMISING THE BIOSPHERE; THE CONCEPT OF THE ECOLOGICAL AND TECHNOLOGICAL REVOLUTION

Activity directed toward nature cannot help having consequences for the latter that are always negative for man. Since man's activity, which has already reached its scientific and technical phase, is inextricable without eliminating man himself, we can say that it is absolutely impossible as well to eliminate its negative consequences. But the system 'activity/consequence' of activity for nature and man himself can be optimised. The basis for the optimisation consists in allowing for certain (in this case six) fundamental methodological conditions.

1. *The principle of the object's active resistance to the subject*. However powerful man's activity becomes, armed with technical means, the environment (until it has been finally destroyed) will not cease to resist his transforming activity. This thesis is a negative expression of nature's structural character and activity. In fact, the environment could not help resisting its transformation by man, unless it were structureless and passive. Since it is not, however, it is possible in principle to eliminate its active resistance, which takes the form of consequences that are negative for man at any level of his scientific and technical power, even the highest. It is in this that the modern content of the problem of the subject's activity consists. The leading controlling impulses to the 'man/nature' system come now from man armed with ever more powerful technical means. The environment, saturated with connections or . . .

which who are gambling on the arms race, so as not really to minimize the harm being done to nature, it is necessary to restructure industry for which economic means are required that can only be obtained by reducing (and in the long run completely stopping) the arms race. The overcoming of the ecological crisis is thus the antipode of the arms race. It is a very peaceful task, which mankind must not delay tackling. The present-day ecological situation is compelling us to recognise more quickly the whole acuteness and vital importance of optimising the biosphere.

The first step in optimising is to realise the extreme acuteness of the ecological problem. This realisation is now acquiring the form of an ecological consciousness that is having considerable influence on modern man's outlook, for whom it is vitally necessary to achieve equilibrium of his activity with the objective laws of the biosphere. Recognition of the ecological problematic and of the multilevel character of scientific theories must mature into the appearance of ethical constructions, and a special ecological morality must be formulated now, in our generation. For solution of the ecological problem is organically linked with the vital interests not only of modern man but also of the mankind's future.

In this connection we would recall Plekhanov's statement that

mankind's moral development follows closely in the footsteps of economic necessity, precisely adapting itself to society's actual needs. In this sense, it can and should be said that interest is the foundation of morality.¹

¹ Georgi Plekhanov. *Selected Philosophical Works*. Vol. 2 (Progress Publishers, Moscow, 1976), p. 49.

Realisation is, of course, only a moment of the minimising of adverse anthropogenic effects on the environment. The essence of the process is itself particularly practical, requiring a restructuring of industry on new criteria. The basis for this restructuring must be the principle of the biospheric minimax, i.e. the achieving of the maximum effect with a direct link from nature to industry and a minimum feedback from industry to nature. Allowing for feedback in the 'industry/nature' system gives this system features of cyclic adjustability, which (as we know) lends a system optimum dynamic stability. A methodologically interesting variant of this optimised activity, allowing for both the direct connection and feedback in the 'industry/nature' system will be non-perturbing activity' expressed, in particular, in a special technological procedure like 'industrial neo-gathering' (which we shall go into in more detail below). The general strategy of technological development needs to be oriented on essentially new criteria.

3 *The criterion of the biospheric compatibility of technical development* Technical development cannot avoid altering the natural component or sphere of reality accessible to man. That is an axiom. It follows from this axiom, however, that neither the ultrapessimistic extreme (suppress technical development!) nor the superoptimistic one (in the final analysis, nature, will withstand any onslaught of technical development!) is legitimate. The way out consists in scientifically substantiating some rational compromise between technique and nature (i.e. rejecting something in technique and rejecting something in nature), and optimally combining them (and not blindly seeking the compromise by trial and error). To do that, it is nec-

of course to modify technical development from the standpoint of the criterion of its biospheric compatibility.

As regards this development on the basis of methodological discussions, which alters the very style of thinking in science, the following significant comment of Hegel's is apt.

'Such rubbish,' it is said, 'as we consider when in our study we see philosophers dispute and argue, and settle things this way and that at will, are verbal abstractions only.' No, no; they are the deeds of the world-spirit, gentlemen, and therefore of fate.'

We do not, of course, accept the 'world-spirit' onto which Hegel would lay responsibility for man's fate. In the twentieth century we ourselves decide the acts of our fate without a 'world-spirit'. The fate of the ecological situation largely hangs on how strongly the ecological component is rooted in the philosophical phenomenon designated as 'style of thinking'. An ecological style of thinking is a style of activity of the subject with limitations stemming from the object, a style of rational compromise between technical development and the environment. These two elements (technical action with biospheric limitations and a compromise of human technological activities and the biosphere) also define the conception of optimisation as the methodological instrument for dealing with the ecological problem.

The criterion of this compromise has to be comprehensive but it is not easy to develop it.

* G. W. F. Hegel, *Lectures on the History of Philosophy*. Translated by F. S. Haldane and Frances H. Haldane. Vol. 2 (Routledge & Kegan Paul, London, 1936), p. 421.

The idea of man's weakness in relations with nature has now become different and more mediated. Weakness is now infinite force, unoptimized in its consequences; weakness is incapacity to coordinate technical power, growing like it at variance with conservation of the biosphere's relative stability and qualitative determinacy.

A certain antidote for this 'weakness' would be the development and spread of a 'sense of nature', the inculcation of a synthetic sense of man's community in their relations with nature, a moral condemnation of any kind of rapacity as a form of robbery of man and his future. Professional clashes between hygienists—'pessimists' and physicists 'optimists'—cannot be tolerated. On the contrary, physics will have the decisive role in real programmes of optimizing the biosphere, but not physics as the science of inanimate nature, but a kind of generalised physics uniting the theory of the animate and the theory of the inanimate.

4. *The criterion of long term stability of the impact on the biosphere* Allowing for the feed-back or reverse link of anthropogenic influence on nature supersaturates the whole 'technique/nature' system with connections; the special complexity is not in allowing for these links in space but in analysing their development in time. The chain reaction (largely uncontrolled, alas) of multilevel technogenic connections gives rise to the most unexpected remote consequences to the biosphere. In materialist doctrine man faces an objective world in his practical activity, depends on it, and determines his activity by it.

In Stendhal's *Journal* we find an instructive argument as regards the problem of the biosphere. He wrote:

feel, in the affairs of life in which I deem myself strong, that I am not at all disposed to take a decision in advance. I am sure that in the circumstances I will do what is for the best.

I am of the opinion that that is the character of strength, because, in things in which I am weak, I have never made up my mind enough in advance. . .

I am therefore of the opinion that the character of strength is not to give a damn for anything and to go ahead !

That conception of strength is still common, especially in relation to nature. We are becoming more and more convinced that human strength consists in harmonising man/nature relations.

The real strength of man's reason consists, we know, in the harmony of rational actions, of rational estimates of their results (products), with the objective course of things governed by the objective laws of being. In order to realise this strength it is necessary to employ exact, quantified knowledge of nature's laws in the sphere of understanding social processes. For the optimality also emerges as sound practice that has acquired an exact, quantitative form of expression.

Estimates of the consequences of scientific and technical development are its most important prerequisite. In order to optimise human activity we need adequate development both of scientific knowledge's real transforming force and of capacity to forecast the consequences of not yet completed effects on the biosphere.

tion and technogenic pollution of the environment. It is not fortuitous that with the crisis in the West the motor car is beginning to be displaced by the (more biospheric compatible) bicycle. Under capitalism, however, this matter is difficult to solve in a systems way.

In stressing the advantages of socialism over capitalism in dealing with the 'industry/nature' problem, Engels remarked in *Anti-Dühring* that 'only a society which makes it possible for its productive forces to dovetail harmoniously into each other on the basis of one single vast plan can rationally distribute industry in the environment so that 'the present poisoning of the air, water and land can be put an end to.'

Community of aims in itself does not, of course, mean some pre-established harmony guaranteed *a priori* by socialism in its relations with nature. The possibility of eliminating pollution can only be made actual under socialism through practical measures. As Lenin stressed:

The activity of the end is not directed against itself... but aims, by destroying definite (sides, features, phenomena) of the external world, at giving itself reality in the form of external actuality.²

6. *The principle of the unity of productive and compensatory activity.* Man's nature-transforming activity cannot help giving rise to unexpected products. The moment of the disparity of productive activity in its direct and side effects, both predicted and unforeseen, calls for constant regulative, compensatory action, based on study of the products of the anthropogenic

¹ Frederick Engels, *Anti-Dühring* (Progress Publishers, Moscow, 1977), pp. 351-52.

² V. I. Lenin, *Op. cit.*, p. 213.

effect on the biosphere. The splitting of activity into productive and compensatory, the development of a 'biospheric compensation industry', and constant concern to improve the productivity of this activity are an important methodological condition for optimising the biosphere. The splitting of activity happens, of course, only in form, as regards content, the compensatory action is not separated from the producing one—they merge and are interconnected. Compensating activity will also not, in the long run, be differentiated as a special type of activity but will be a form of a diversity of optimised, harmonised, integrated activity acquiring the features, in combination with nature, of a 'self-isolated state', i.e. of endless, stable, cyclic recurrence. There are already plants in operation that, for example, produce soil on the sites of worked-out quarries and opencast mines.

An important and ever greater mass form of compensative work in the age of the scientific and industrial revolution is control activity that is outwardly expressed in the form, as it were, of inactivity. While everything goes right man follows but without outward exertion, seeming 'inaction' (at the same time, of course, ready to act, i.e. in a tense state, consequently, associated with expenditure of physical and mental forces). In the long run, when the producing of mass batched consumer goods on ever greater scale is transferred to automatic machines, work in the sphere of compensating production will be more creative and more skilled, involving more people, and calling for increasing outlays. In subsequent, still higher stages of the development of machine civilisation, of course, even compensating activity will be automated. In any case, however, it is compensating activi-

that will express the basic forms of society in a new and more stable form.

The present situation is rather like that of a family which has grown too fast and is going to burst its clothes. It still has a lot to live for, it is necessary to convert labour into a real commodity of value and to limit production. It is hardly useful to have a lot of workers for the same job, but the situation is at present such that the value of work

A thing can have a value, without having value. This is the main difficulty of utility to man's material life. Labour is not the only and natural measure of

that there is no economic, practical belief in the age of the monetary and industrial production, but now when the scale of man's productive activity has become global in character, it is more and more becoming clear that that plane we can now speak of a kind of value of all value of work, and so on.

The methodology of optimising the biosphere, as we see, is a multilevel one. It provides a broad theoretical programme of action for a practical way out of the present-day ecological situation and for overcoming the crisis of society.

In order to create a favourable ecological situation for the successful development of society, it is necessary to create a new biosphere-compatible type of industry as well as to improve social relations. The transition to it has so many planes (it, in turn, requires a fundamental restructuring of research as well, from applied to basic), that we are faced essentially with a new technological revolution as the real mechanism for optimising the biosphere.

¹ Karl Marx. *Capital*, Vol. I. Translated by S. Moore and E. Aveling (Progress Publishers, Moscow, 1974). - 43.

3.2. THE METHODOLOGICAL PREMISES OF THE ECOLOGICAL AND TECHNOLOGICAL REVOLUTION

Science that allows for the consequences of man's technical interference with nature will be the basis of a new biosphere compatible technology. The dialectical methodology of this science will naturally, at the same time, be the theoretical basis of the technological revolution that will be needed so as to liquidate crisis trends in the biosphere. Like any revolution (in contrast to a revolt) the technological revolution will include an essential moment of conscientisation. It is necessary to control it in a planned, stage by stage manner. For technique is a system open at both ends—from man, and from nature. Its intermediate position provides it with the possibility of being both a means of bringing man and nature closer together and a field of hopeless conflict between them.

In our view the ecological conflict situation taking shape cannot be overcome through planned, gradual growth of the elements of existing technology. What is needed is a qualitative leap transforming the very methodological principles of past and present technological development. The need for a technological revolution in order to deal with the ecological problem is dictated both by the scale and the character of modern technical development (anti-nature and aggressive in relation to the biosphere).

When men transformed stone and wood by labour the scale of their activity was not great, and furthermore had a nature like character.

Things are different now. An essential feature of the present-day scientific and industrial

revolution is connected in a way with the fact that the whole biosphere is involved to one degree or another in the production process. Whole biosphere is worked on and the ratio between wild and humanised nature is being sharply altered in the direction of latter.

Furthermore the acts of human activity—becoming compatible in instrumental capacity and power with immense natural processes—consequently man is acquiring the technical capacity to alter the environment radically—to change the direction of rivers and sea currents, raise mountains and fill basins.

There are two new moments in this, namely mastery of all regions of the planet (even abyssal depths) and acquiring of the technical possibility of altering the biosphere in aggregate relatively rapidly, and they constitute a general tendency to biospherisation science and technique. Biospherisation in itself is a very great technical achievement, but as such it is neutral in a human sense, i.e. it may be open equally for good and for evil.

The biosphere, of course, functions primarily as a system of two interacting parameters—the biogenic and the abiogenic. After millions of years of joint development these parameters have attained a high degree of mutual correlation. The sphere of production or, as Khilmi puts it, the technosphere, used to play a relatively insignificant disturbing role in the biosphere processes.

But now things are different. The growth of the scale of production by leaps and bounds, and the urban processes accompanying it, have led to the formation of a third parameter of the biosphere, alongside the biogenic and abiogenic

which may be called the 'antibiogenic' parameter, i.e. one disastrous for the biological systems of our planet.¹

The products of urbanisation like asphalt ('asphalt civilisation'), the product of the working of various kinds of technical installation (carbon monoxide), and various artificial chemical compounds (especially macromolecular ones) are becoming the most important elements of this antibiogenic parameter. Their harmful impact on man and everything living is obvious. It is a matter, essentially, here, of the chemical aspect of the conflict between technique and the biosphere. It is quite necessary to avoid the negative consequences of technique, which are disturbing the chemistry of the biosphere, or to reduce them to the minimum.

People often try to explain the chemical aspect of the conflict between technology and the biosphere simply by the unsatisfactory level of development of contemporary technique. The next level, they say, will eliminate the conflict. The reliance on automatism in optimising the biosphere associated with this approach, it seems to me, could foster irresponsible illusions about problems of the biosphere being allegedly solvable without special efforts and being self-eliminating.

Today this conception of the solution of the conflict between technique and the biosphere is called the level concept. According to this approach the antibiogenic nature (in the chemical

¹ The biogenic parameter is animate matter, the abiogenic parameter inanimate matter, which serves as the condition for the existence of animate systems; the antibiogenic parameter is pollution of the biosphere.

development of certain elements of technique (of a given level) is simply the result of their undeveloped character. At the next, higher stage of the technique it proves the conflicts of the preceding one will be extreme and it will become possible either to damp waters as far away as one wants or to eliminate them altogether. The supporters of this point of view often speak of the possibility of building taller and taller chimneys (the high chimney phenomenon), the higher the chimney allegedly, the purer the air becomes, although atmospheric pollution will grow on the whole or of going over from internal combustion engines to electric motors in urban conditions (the electromobile phenomenon).

The level conception of technical progress mentioned above in spite of certain rational moments, is hardly suitable to substantiate optimisation of the biosphere methodologically. On a certain plane this approach can even lead to consequences harmful for the biosphere. We can say, for example, that it is not proved that the electromagnetic waves from electromobiles can be easily screened to render them harmless for townsmen.

While we still have a sufficient quantity of energy we can manoeuvre in the field of technological possibilities. For there is no absolute energy crisis yet on the Earth. Furthermore, scientific and technical advance holds out a promise of an abundance of energy resources. The increment of proved fuel resources, for example, (not counting nuclear 'fuel') has overtaken the growth in expenditure of energy in recent years, and even the very rapid growth of population in certain countries. Yet, however, there is talk more and more often about damped technical and economic curves

oxygen, of which there is now beginning to be a lack everywhere without that. These peculiar metal graveyards have created a special industry in the USA the briquetting of motor cars to charge blast furnaces. In recent years, however, the industry has begun to disappear because it proved unprofitable extra collection of scrap proved unnecessary, while the mountains of old metal began to grow rapidly; and what to do with them now nobody knows. That example is not the only one in today's civilian world, unfortunately.

The second problem is no less complicated. It is connected with the change in the biosphere's parameters. Scientists in many countries are having to deal, today, with the problem, for instance, of where to dispose of the heat that is being ejected into the atmosphere. The problem did not use to arise because the energy was comparatively small and the surplus heat was dissipated in the lower layers of the atmosphere without complication. But now the situation is beginning to change.

The problem of surplus heat is being complicated by the fact that a shortage of oxygen is arising in cities. The relatively pure air needed for breathing is becoming less and less, with the result that there is less and less vegetation on our planet, especially in cities. The exhausts of technique yield much carbon dioxide, the atmosphere is becoming 'cloudy', and the Earth is being rapidly heated by that. It is also suggested that this heating is associated with certain nuclear processes in the centre of the Earth. An additional and very considerable contribution to this heating up is also being made by our scientific and industrial revolution. None of these more or less indifferent for the Earth's biosphere,

because the continued heating could lead to the melting of ice, and heavy flooding, the submergence of certain areas of land, and a raising of the sea level, which it has been calculated could rise by 60 metres and lead to disaster.

All that presents mankind with serious problems of maintaining the parameters of the biosphere needed for life.

Two components needed for human life are directly threatened in our day, namely air and water. Above all water. Seemingly semi-fantastic prophecies were sometimes made that already in the late 1970s, water would begin to be rationed in industrially developed capitalist countries. The same can also be heard about clean air. In industrial cities where there are many motor cars and a correspondingly too high level of exhaust gases a special term 'doormen's anaemia' is in use for the oxygen hunger of persons living or working on the ground floor of buildings. On polluted main thoroughfares air fit to breathe often only begins at the second floor up; lower down it is still so poisoned as to lead to lamentable consequences.

There is no doubt that fauna are in a very grave situation on Earth. It is sometimes said that man will ultimately be living in an environment in which only domestic animals survive. It is quite plain that river and marine fauna are already in a quite complicated situation, fish cannot be caught in many parts of the ocean because the level of radioactivity is sometimes too high, while they are dying in other areas because of technical wastes.

A kind of turning of scientific and technical progress into a calamity is taking place. The more clothes, television sets, and motor cars there are, the worse man's biospheric needs con-

nected with the need to live in an appropriate environment are being met.

Industry is being improved and perfected, as we know, through technical progress, and also agriculture in which a 'green revolution' has occurred. In some developed countries one person employed in agriculture can feed a score or more of townsmen not simply because of mechanisation but so because the main means of production in agriculture, the soil, is being intensively dressed with chemicals of all sorts, and pests & farm plants are being exterminated by special chemical preparations.

There was a real revolutionary turn in the field in the post-war period after the invention of DDT. This discovery was even awarded a Nobel prize. But active universal use of DDT led to grave consequences. Its use has had to be banned everywhere because it not only proved to be destructive of harmful insects but also turned out to be extremely dangerous for man (because of its capacity to accumulate in plants that people eat).

Similar phenomena have been observed even in industry. Progress in machine production was traditionally connected with breaking down the production process into separate operations, a quantisation of technology. With it there was an unavoidable loss of matter and energy dangerous for the biosphere (pollution) in the passage from one technological block to another.

The transition to a continuous, closed technological cycle evidently constitutes the principal content of the technological revolution ('continualisation' of production) that is being carried out to resolve the ecological problem. This revolution in technology corresponds, of course, to the trends of the change in the very style of

thinking in the fundamental sciences. It was not by chance that Einstein had already written to Sommerfeld in 1916: I still believe in all earnest that civilization of the basis of physics will come from the continuum.¹ Later there were similar trends in the theory of automata expressed in von Neumann's classic work.²

The logic of the technological revolution thus corresponds to the logic of the change in style of thought in fundamental work. This circumstance can be exceptionally important since it helps tie up fundamental research with technological processes by passing the stage of applied technical development in which considerable informational clutter may occur (responsible to a certain extent also for atmospheric pollution). The provision of a high degree of unity of fundamental science and technology is an important argument in favour of the continuation and cycling of production. Technological cycles, however, are not, of course, the panacea for all ecological ills, if only because full cycling of production is impossible since it would contradict the second law of thermodynamics. Furthermore, it would mean absolute isolation of production from nature, which would contradict the nature of labour as the permanent exchange between man and nature inherent in any technical progress.

From a more general standpoint the ecological-technological revolution does not amount to

¹ Albert Einstein, Arnold Sommerfeld *Briefwechsel* (Schwabs & Co., Basel/Stuttgart 1946) p. 121.

² J. von Neumann. The General and Logical Theory of Automata. In Lloyd A. Shilcock (Ed.) *Cerebral Mechanisms in Behaviour. The Hixon Symposium*. New York, John Wiley & Sons, Inc. London Chapman & Hall, Limited, 1951.

some one technological method, however effective it will signify a higher stage of production activity in accordance with the limit of reality itself. Any other approach is bound to be worse. In that statement we see the important element of the methodology of harmonising man-nature relation.

Three strategic directions can be distinguished in the general methodology of harmonising the man-nature system:

The first line is that of the methodology of isolation. It assumes that production can be isolated from nature by introducing technological cycles into the various fields of productive activity, so saving nature from the harmful wastes of production. For example, the question is now posed, in dealing with the complicated problems of the water balance, not simply of building purification plant to clean effluent but in general of a technology without effluents. It is hoped that if it were so arranged that enterprises' effluent were discharged onto sewage farms, and not into reservoirs, the planet's fresh water would become cleaner. Pollution, however, would not be stopped because there would be evaporation from the surface of the sewage farms and an intensification of fallout of contaminated precipitation onto the earth.

The isolation of production from nature can obviously only be relative. In general one of the lines of harmonisation cannot resolve all the problems facing us in this field.

The second line is that of the 'methodology of compensation'. Man's activity, as we have said, is gradually splitting into production activity and activity compensating the consequences of production harmful to the environment. This compensation may take the form of more active

areal dispersal of biologically significant fragments of the environment

In recent years, for instance, the sale of pure water from Finnish lakes in Cellophane packages has been organised in cities (especially in West Germany)

The third line is that of the 'methodology of spatial extrapolation'. Since scientific and technical progress is linked with growing spread of human activity in space, it can be hoped that the rates of increase of areas accessible to man will always be bigger than the rates of increase of production's specially harmful wastes.

The atomic industry, for instance, has a low amount of wastes, by weight, and the transition to industrial thermonuclear power will reduce them even further. It is conceivable, accordingly, that these wastes could be shot in rockets out beyond circum-terrestrial space. It has even been suggested that it would be best of all to fire them all into the Sun. But that proposal would give rise to the danger of repeating on another scale the situation on Earth, which had been forced to manage to serve to a certain limit as both the feeder of life and the receptacle for the wastes of life's activity, and had then come to be saturated. It might be so also with the Sun, besides which we also risk disturbing its activity, for which the living would have to pay.

It can be supposed that the centre-of gravity of all the changes will shift in general from transformation of nature to transformation of human activity itself in accordance with the biosphere's laws, which would lead to its radical restructuring. Progress in the technological mastering of outer space, for instance, may provide the possibility of power installations in ~~outer~~ terrestrial space (and not simply of ~~outer~~

It should also be noted that a first part of utilising material goods is gathering. In other words, only greater intensiveness of using with recycling and the production of the best and most responsible for gathering products is over decreasing rate in man's layer over the old lemma and finally an alternative one. New forms kinds of gathering may again acquire some significance in the form of re-gathering, especially its power engineering.

Solar energy and utilising of winds and the forces of the earth may acquire great weight, given modern scientific and technical possibilities. These parameters exist in the biosphere, man simply needs to redistribute them in space. This is an interesting line in the struggle for energy without anthropogenic wastes.

Use of the elements of re-gathering, whenever possible, is far from decisive, of course, but it is an essential methodological condition all the same for optimising the biosphere.

Optimisation of man's relation with nature is undoubtedly realisable, but it will never be ab-

solute, idyllically complete in any of its versions, certain contradictions will remain and consequently development will not cease. The degree to which relative ecological contradictions are overcome without reaching conflict scale depends on the given social relations on the level of development and organisation of scientific knowledge.

3.3. DIRECTIONS OF TECHNICAL PROGRESS AND OPTIMISATION OF THE BIOSPHERE

The age of the scientific and industrial revolution is one of great achievements, which are being put to the service of building communism in Soviet society. In the long term planning of this development classification of the outlook for material and technical progress, allowing for the possibilities of the biosphere and its optimisation, has an important role. The allowance is made on an economic basis.

The eminent Soviet meteorologist Fedorov justly stresses:

Assessment of the damage caused by pollution, together with allowance for the cost of purification plant or the introduction of new technological processes that will reduce pollution, is (as will be readily understood) of real significance for long term planning of economic development.¹

We shall discuss certain methodological aspects of this matter in connection with the problem of optimising the relation between technique and the biosphere.

¹ E. Fedorov *Ekologicheskiy krizis i sotsialnyy progreys* (The Ecological Crisis and Social Progress) - Gidrometeorizdat, Leningrad, 1977, p. 160.

The Ecological, Energy Aspect

As technical progress advances man will master newer and newer forms of matter and learn to interchange them. In the long term this trend may lead to a technology based on the principle of 'everything from everything'. And since our planet has a surplus material balance, it loses much less matter into the upper layers of the atmosphere than it receives from outer space (e.g. in the form of meteorites), the quantitative limitation of matter cannot apparently become a major natural limitation on man's activity.

In the *Scientific American*'s 1970 symposium on the biosphere, for instance, a hypothetical model of a 'granite civilisation' was developed. This model assumed in principle the possibility of obtaining the material and energy needed by man from granite rocks. A ton of granite, Harrison Brown said, contains technically extractable uranium and thorium equivalent energy-wise to about 15 ton of coal, so the new stone civilisation would be guaranteed energy. In addition all the elements needed for intensive technical development could be separated from granite.²

We cite his example so as to stress the very important role of the energy aspect of the ecological problem compared with all other technical problems. When convertible energy is put at man's disposal two main difficulties conne-

¹ E. Fedorov, Current Problems of Society's Interaction with Nature, *Kommunist*, 1972, 14.

² See: Harrison Brown, Human Materials Production as a Process in the Biosphere, *Scientific American*, 1970, 223, 3: 208.

ed with the inter-relation of technique and the biosphere are overcome.

(1) There would then be enough energy not only to carry on production activity aimed at meeting needs but also to carry out compensating activity aimed at attenuating consequences harmful for the biosphere. (2) Having more energy resources at his disposal man could comparatively easily transform and alter technical systems with consequences harmful for the biosphere.

It is necessary, of course, to take care in this that the production of energy itself is not accompanied with significant pollution of the environment. The use of atomic energy, and in the long run of thermonuclear energy, will open up very reassuring prospects on that plane.¹ We shall not go into details about these prospects, in the context of our theme we shall analyse one methodologically fundamental moment. This is that discussion of the prospects of thermonuclear power engineering is often accompanied with the illusion that man will become the possessor of an infinite amount of energy and will henceforth increase it as much as he wants, thus an eminent scientist remarked, back in the 1920s, that man would be able in the abundance of the atomic age to do everything he wanted. In the light of the present ecological situation the illegitimacy of this approach is obvious.

Possession of a great quantity of energy is a *sine qua non*, of course, of technical progress. A shortage of energy, on the other hand, and an increase in its cost are undesirable for all

¹ V. A. Venikov. Power Engineering and the Biosphere. In I. B. Novik et al. (Eds.), *Metodologicheskie aspekty issledovanija biosfery* (Nauka, 1975), pp. 53-71.

the surface of neighbouring continents would be the result of such a development that perhaps of all the paper will become power of 1000 terawatts if the energy can be used at present at the same rate. This would be eight times our needs, if taken off all available sources of electricity to produce one tonne of paper a year.¹²

But energy is a constraint of technology for development not only when it is in short supply but also when too much is present. The limit in the sphere of the exchange of power among the interactions of man and nature is also connected with man's being unable to put more than a certain fraction of the energy received from the Sun to his use. Semenov emphasises for instance that the amount of energy produced could be raised by means of thermonuclear fusion, to 2000 to 7000 times the amount now obtained from burning fossil fuels, yet that would not be more than 1 per cent of the solar radiation reaching the Earth's surface.¹³

The total energy that could be obtained in addition to the solar energy reaching the Earth's surface could thus cause a rise in temperature of 3.5°C.¹⁴ The figures are not definitive and do not take 'greenhouse effect' into account. Contemporary methods of obtaining energy are mainly based on burning various kinds of fuel in technical installations with consequent production of carbon dioxide. The CO₂ liberated is partly absorbed by plants and bound in organic compounds, considerable quantities are also dissolved in sea water with subsequent formation of carbonates. In spite of all these buffer effects

¹² N. N. Semenov A Propos the Power Engineering of the Future. *Nauka i zhizn'*, 1972, 10: 21.

¹³ *Ibid.*, p. 22.

however, an increase is now being observed in the CO₂ content of the atmosphere, which is leading to intensive absorption of the Earth's infrared radiation and in the longer term may promote considerable heating. The warming of the Earth by heat of technogenic origin is increased by the 'greenhouse effect'. It is already necessary to add radiation heating to this phenomenon because of the atomic decay reactions taking place in the interior of the Earth.

By the year 2000, for instance, mankind will be using 25,000 million tonnes of standard fuel against 9,000 million tonnes in 1973.¹ The increase in consumption of energy resources will also cause an increase in the technogenic heating of the planet. It will already become urgent to allow for these new circumstances by the end of the century, when the colossal opportunities contained in thermonuclear reactions will be opened up. For the first demonstration reactor will be built in the 1980s and it is suggested that the first industrial thermonuclear reactors will be built by the end of the century.² There are still many difficulties in the way, but developing scientific theories are showing how to overcome them. The complexities of keeping plasma in a stable state, for instance, have led to the idea of creating a "pulsed" thermonuclear reactor in which the process taking place will be of an explosive character.³ One way or the other the problem of thermonuclear energy, it must be supposed, will be solved, for mankind only sets itself resolvable tasks, and it is neces-

¹ V. V. Kirellin, Energetics: the Present Position and Outlook, Priroda 1975, 3-4.

² *Ibid.*, p. 22.

³ *Ibid.*

ary for the solution of the next one to be rational economically as well as energy-wise.

With a raising of temperature (if the 'barrier' were broken), the polar ice and the Greenland ice-cap would begin to melt, and as a result of the no longer hypothetical but real flood the greater part of the Earth's surface suitable for human life would disappear under water. The special danger of this process is that the melting could occur at a catastrophically increasing rate, because it would alter the albedo of the Earth's surface and absorption of solar energy would consequently increase. Budyko writes:

The existence of a feedback between polar ice and the Earth's thermal regime considerably increases the latter's dependence on external factors and gives the Earth's contemporary climate an unstable character.¹

In addition, an increase in the surface temperature of the Earth would entail a negative, largely unstudied effect on the dynamic equilibrium of the communities of microorganisms in the water and soil of middle latitudes and lead to a substantial rise in the humidity of air. The unstable character of the Earth's climate, and great ramification of the negative effects on the biosphere if it were altered, call for forecasts of the thermal state of the Earth substantiated by thermodynamics and allowing for the use of an ever increasing amount of energy.

We thus see that the essence of the problem discussed above is that the total amount of ener-

¹ M. I. Budyko. The Energetics of the Biosphere and Its Transformation by Man's Action. *Izvestiya AV SSSR, seriya geograficheskaya*, 1971, 1: 10.

The needs of the development of aerospace technique itself (assembly areas outside the Earth, and extra-terrestrial repair depots) are playing an important role in determining trends toward transferring some technological processes to outer space.

Mastery of outer space is associated with economic tasks and communication systems operable from outer space. Much has been said in recent years about moving the 'dirtiest' forms of production into outer space and of dumping specially aggressive pollutants into outer space (by means of rocket 'dust-carts'); it has been suggested, for example, that rockets loaded with radioactive wastes from atomic power stations be fired at the Sun. At a seminar of astronomers I heard the following colourful thesis: 'the Sun is the Earth's natural dust chute'. Consideration and caution are needed, it would seem, in such expressions (the available facts indicate that). The Americans' notorious firing of needles into circum-terrestrial space provided evidence of its extremely limited assimilative possibilities; rubbish is conserved there but not digested or processed. Pollution of circum-terrestrial space can quite quickly affect the terrestrial biosphere. Furthermore, the danger of a small action triggering a gigantic catastrophic process is great: the Sun, for example, is a gaseous sphere, and it is very dangerous, in our view, to disturb its stability. It is obviously more reasonable to use outer space as an ecological niche for production processes on some other plane, viz., to look for those forms of production that, while pollutants in Earth's conditions, would not be such in outer space, or would at least be less toxic there.

One of Chekhov's characters, Vasily Semenov, had clearly posed the question of the

human life of extra-terrestrial space in the last century, as we know, even taking the ecological factor into account. Discussing the possibility of life on the Moon he remarked in his letter to a scientific neighbour, 'Sewage and garbage would spill down on our continent from a populated moon'!¹ True the ecological situation in outer space ultimately proved to be all right, and settled, for Chekhov's character, because the existence of people on the Moon was refuted by its being impossible to live there, by Semen-Hulakov's logic how could they, 'if they exist only at night and disappear in the day-time'?²

That was no doubt a joke of Anton Chekhov's (Chekhov's pen name), but one surprisingly recalls it when thinking about the possibility of circum-terrestrial space becoming contaminated.

The technical aspect of the industrial mastery of outer space will apparently be resolved quite effectively. The putting of one kilogram load into circum-terrestrial orbit now costs \$1,000 according to American estimates, and may fall, moreover, to \$600 in the next few years, and in the long term (after the building of re-usable shuttle spacecraft to \$100).³

These new opportunities, however, will not only not eliminate the ecological problems but will also, on the contrary, require consideration of their special ecological, space aspects for their successful development.

¹ Anton Chekhov A Letter to a Scientific Neighbour *Sobraniye sochinenii*, Vol 1 (Goslitizdat, Moscow, 1960), p. 5

² *Ibid*

³ I. Belyakov and Yu. Dorisov, *Op. cit.*, p. 101.

The 'composition' of elements of production will give rise to a need for a kind of space ecology in a scientific trend associated with description of the properties of the environment in outer space and modelling of their effect on technological materials and the technical systems made from them.¹ It will also be necessary to allow for the features of space essential to production activity. Because of the fall in atmospheric density for instance the 'sky' will become 'black', at heights of the order of 150 kilometres, i.e. absolutely transparent.² Another serious ecological space problem is connected with what is called vacuum adhesion (welding).

The sticking together of materials (cold welding) is a characteristic ecological condition that space technology must take into account. In the vacuum of outer space any material (metal or non-metal) loses all the gases absorbed on its surface and becomes 'clean'; as a consequence they can be stuck together when their surfaces are brought into contact, or cold welded. The phenomenon has been studied experimentally. As Belyakov and Borisov remark, cohesive force increases with rise of temperature, and at a certain temperature may reach 95 per cent of the force needed to break a specimen in ordinary conditions.³

The space conditions associated with gravitation are peculiar. On spacecraft moving in a circum-terrestrial orbit, for instance, a body not

¹ I. Belyakov and Yu. Borisov, *Op. cit.* In article ('The Modelling of the Space Effect on Substances, Materials, and Equipment').

² *Ibid.*, p. 11.

³ *Ibid.*, pp. 85-86 (Ch. 3. Alteration of the Properties and Behaviour of Materials under the Conditions of Outer Space).

at the centre of mass will be affected by micro-gravitation. Weightlessness occurs only at the centre of mass of a spacecraft or other such system in orbital flight¹

Many processes 'difficult' in Earth conditions will be transferred to circum-terrestrial space in the not distant future²

Let us take an example. In outer space a crystal can be successfully grown from melts, thereby achieving great purity³. The quality of computers on the Earth, for example, depends, as we know, on the purity of silicon crystals. We can therefore conclude that rationally organised mastery of outer space could help men overcome the contradiction between technique and nature, but this help must not, of course, be understood in the naive consumer spirit that once we push forward into outer space we can completely pollute the Earth and fly off to 'clean' worlds.

The Ecological-Bionomic Approach

One of the outlooks for the development of technique being discussed is connected with switching it onto the rails of biological laws. One of the creators of nuclear physics Frédéric Joliot-Curie spoke of this in particular, addressing the USSR Academy of Sciences in Moscow in 1949, remarking that, although he believed in the future of atomic energy and was convinced of the importance of this discovery, he considered, however, that a real turn in energetics would only occur when mass synthesis of mol-

¹ *Ibid.*, p. 40

² A. D. Ursul. The Space Trend in the Interaction of Society and Nature in: I. B. Novik et al. (Eds.), *Op. cit.*, pp. 169-91.

³ I. Belyakov and Yu. Borisov, *Op. cit.*, p. 145.

ecules analogous to chlorophyll, or of even higher quality, was achieved.

Semenov drew attention to this perspective in his article referred to above.¹

Discussing the possibilities of creating an artificial photosynthesis reaction, he spoke of the high efficiency of the transformation of energy in living organisms. Such trends of research are extraordinarily promising from the angle of intensifying anti-entropic processes in the biosphere. It is in this field that we must expect the invention of power devices more in accordance with the principles of biospheric compatibility.

In addition to employing the energy of the microworld and achieving controlled reactions of nuclear synthesis in terrestrial conditions, man must utilise the energy of the macroworld more widely, i.e. the gravitational energy of the Earth-Moon system, because this energy, in the form of tidal energy, is dissipated in the biosphere, in any case as heat.

Life is at once both a form of the transformation of energy and its degradation, but this degradation occurs in the biosphere in conditions of the special anti-entropic activity of living matter. Each cell of animate matter is the arena of a developing struggle between entropic and anti-entropic processes, and the natural biosphere is the victory of life and triumph of the anti-entropic principle. One of the most important conditions for harmonising the "man/environment" relation is deep penetration into the thermodynamic patterns of the biosphere's functioning.

¹ N. Semenov. *Acta cit., Nauka i zhizn'*, 1972, 25-32.



there is energy in the sun we might not be here¹ for all sorts of other processes in the air, water, rocks, etc., are not occurring, and if there were no living organisms among plants or animals it would take too much time to use up all the energy. But energy of a special kind of the high entropy content needed by living organisms that is chemically released by combustion. The founder of thermodynamics in an address to the British Association, he said:

The general struggle for existence of living creatures is often very hard for the basic elements the elements of all organisms are present in abundance in the water, and the soil, or for energy, which is unfortunately contained in abundance in any body in the form of unconvertible

¹ S. R. de Groot, *Thermodynamics of Irreversible Processes* (North Holland Publishing Co., Amsterdam, 1951), pp. 24-37.

² L. Prigogine, *Vvedenie v termodinamiku nevsekh mykh protsessov* (Introduction to the Thermodynamics of Irreversible Processes), Moscow, 1958, p. 102.

heat, but is a struggle for the entropy that is available through the passage of energy from the hot Sun to the cold Earth¹

But not all organisms can maintain their vital activity directly by means of solar radiation. Only the process of photosynthesis provides the opportunity to fix this energy and negative entropy in the form of growing organic structures. The energy of solar radiation thus becomes available and comes into the sphere of the metabolism of living organisms in the form of complex organic molecules. The special, hierarchically structured organisation of the biosphere makes it possible for this energy to be distributed over the various levels of the tropic pyramid and energy processes of biotic origin to be self-regulated. The first, initial link in the trophic chain is the phytosphere, which consists of green plants and phytoplankton, which assimilate approximately one per cent of the solar radiation reaching the Earth's surface. The second level of the pyramid are herbivorous animals and organisms whose vital activity is completely dependent on the state of the phytosphere. They do not utilise more than ten per cent of the energy assimilated by the autotrophic organisms of the first level. Finally, the third level, which consists of carnivorous animals some of which utilise the energy of the first level as well as of the second, is the highest. Man belongs to this third level. The inter-relations of living organisms within biocoenoses, their numbers, and the stability of the biocoenoses themselves lead themselves to certain approximate mathematical interpretations, as has been demonstrated by Volterra, Kolmogorov, and Lyapunov.

¹ Ludwig Boltzmann, *Op. cit.*, p. 40

One can try and base the modelling of technical systems on the biogenic component of the biosphere along biological like principles as opposed to traditional physico-chemical ones. That way a whole class of human devices becomes prospective, beginning with the famous artificial muscle capable of contraction. True, progress in this field over the past 20 years has been slower than one would wish.

Great hopes are attached to obtaining food-stuffs from algae like *Chlorella*. It is sometimes proposed to build plant to produce new species of bacteria, but the tangible results in this field are still small. Furthermore the contribution this line could make (if it were successfully developed) toward resolving the ecological problem is still not sufficiently clear.

In general it is not constructive to counterpose biologised and physico-chemical technologies. Rather, it is necessary to integrate the different trends. As regards the ecological effect of biologised production on the environment, it calls for special caution and repeated modelling. For it would be no less imprudent to suggest, without adequate substantiation, that production of a biologised character, i.e. associated with modifying biogenic material, would be obviously harmless for the environment and man himself. For the biosphere, as we know, has both biogenic parameters and abiogenic ones organically linked with them. Interference with the biogenic component of the biosphere unco-ordinated in its consequences (e.g. insufficiently considered saturation of the environment with new species of micro organisms) could be even more dangerous for man than the present pollution by technogenic toxicants.

It is important to remember a special type

of chemical pollutant of the environment, mycotoxins, when discussing the biologisation of technology and the possibilities of the microbiological industry, as Krotkov has stressed, i.e. poisons given off into the environment by microscopic fungi.¹ These poisons are a concomitant of the microbiological industry, and their harmful effects have not yet been properly studied. The possibilities and limitations of biologised technology may be brought out more fully in the course of further research.

The Ecological-Production Aspect

Green plants have a very low efficiency—around 15 per cent—in transforming solar energy, but on the plane of the biosphere's laws it is a very good transformer, because it does not cause disturbances harmful to the environment. In other words, the 'plant power unit' works provided it minimises increase of entropy. In the present ecological situation this condition of minimising the increase in entropy accompanying some technological process, functions as an important criterion for assessing the process itself.

From the standpoint of minimising increase in entropy it becomes clear that an orientation on extending the compensatory activity that accompanies production activity, is needed at the present time, but is not optimal. Purification plants, for example, are themselves a field of pollution of the environment, and the result of the processes taking place in them can only be to increase entropy, which is inseparable in general from any real process taking place in a

¹ F. G. Krotkov. Environmental Pollution and Problems of Hygiene. *Priroda*, 1973, 5 (717), p. 61.

closed system. And if a purification plant is really to serve to improve the environment, it must be an open system, and we can clearly picture where the negative entropy must come from so that the process would not be so entropic. Most purification plants at present utilize the processes of self-purification taking place in nature, but we must remember that natural biospheric processes of purification also expend the negative entropy of the environment's free energy. Hence it follows that we must endeavour to create production facilities that include two kinds of activity, viz., production and compensatory, and consequently must consider it the role to create production processes such as will ensure a minimum increase in the environment's entropy.

Any natural process taking place in the biosphere, including those caused by man, is entropic, i.e. its character is governed by the second law of thermodynamics. Growth in the variety and complication of the separate fields of the biosphere, and the development of civilisation as a whole, should not give rise to illusions about the special, absolute, negative entropic role of living creatures. I would like to stress the full applicability of the second law of thermodynamics to the artificial processes created by man in developing the principles of man's biospherically-compatible activity, it is methodologically important to stress the relatively anti-entropic role of living creatures, and in particular of man. It would be a serious error, leading to subjectivism, to absolutise the anti-entropic aspect of man's activity.

What is the essence of anti-entropic processes and how can they occur in the biosphere? Living organisms and the whole biosphere *in toto* are essentially open systems in which there

can be anti-entropic processes on condition of a delivery of energy to the surrounding medium or, in other words, on condition of receiving the medium's negative entropy. The prime source of this negative entropy is that of the energy of the microworld liberated in the Sun's reactions of nuclear synthesis. The stability of the structure of the tropic pyramid in which the remains of organic forms do not cause pollution but constitute a very important element of terrestrial life—humus—in turn guarantees cyclicity in the working of the 'biospheric machine'. This is cyclicity, of course, only as regards matter, the biospheric machine does not know wastes, but these cycles themselves can be constantly reproduced only because of an influx and constant provision of energy from outside.

A tendency naturally arises (in the present ecological situation) to pass, on the basis of intensifying the means of obtaining energy, to a cyclic technology in industrial production that would be accompanied with a marked reduction (ideally the complete elimination) of material wastes. This process of restructuring the productive forces is so fundamental that it is essentially a matter of a radical technological revolution destined to create technique conforming fully with ecological principles. It follows that this will be an ecological-technological revolution in nature. It was predicted already by Karl Marx when he wrote that as science and technique progressed, they would be able 'to throw the excrements of the processes of production and consumption back again into the circle of the process of reproduction' ¹ and that, he sug-

¹ Karl Marx, Capital, Vol. 1. Translated by Samuel Moore and Edward Aveling (Progress Publishers, Moscow, 1974), p. 567.

grated, 'without any previous outlay of capital creates new matter for capital'.¹ Realisation of this transition from an open technology to closed one will call, of course, for ever greater efforts. The need for them is obvious, if we take into account the growing mass of production wastes. In the United States, for instance, they had already reached 4,400 million tons in 1971.²

Modern technological processes have in fact, as a rule, been made discrete, divided up into separate operations. The success of the most important instrument for raising the efficiency of human activity, namely the division of labour, was linked with that, but now, during the scientific and industrial revolution, the extreme division of labour is leading to a number of detrimental consequences. A general social task of integrating human activity is arising. In the light of that, the whole importance of overcoming the discontinuity of technology is obvious (for harmful wastes are thrown into the atmosphere at the junctions between production operations).

The ecological, methodological principle of 'continualisation' of the production process as new technique is developed will be ever more fully comprehended and introduced into technical schemes, designs, and systems. Prof. B. N. Laskorin drew attention to the need for radical changes in technology, given the present ecological situation, in his paper at the general meeting of the USSR Academy of Sciences on

¹ Ibid.

² R. Novikov, Ecological Aspects of Capitalism's Deepening Contradictions. *Mirovaya ekonomika i mirevnoye sotsialisticheskoye*, 1975, 2-4.

problems of defence of the biosphere and rational use of biological resources (21 June 1973).¹

Several billion roubles will be laid out up to 1985 on building purification plant in the main industries of the USSR; hundreds of millions of roubles are already being spent annually to operate such plant. Citing these facts Laskorin stressed that these measures, however, will not solve the problem of defending the biosphere from industry's detrimental effects.² Furthermore, he noted, 100 per cent cleansing of air and water by known technologies was not economically feasible. He concluded from the data of a special Soviet commission of scientists that a large quantity of wastes was not inevitable and could be eliminated by creating new technological methods.³

Several examples of such new technological methods were given in the paper.

As is known, many chemicals are used up to neutralise chemical products, but there are prospects of using electrolytic processes with ion-exchange membranes or 'ion screens'. Membrane technology is being successfully employed to separate liquid and gaseous mixtures and create waste-free technological schemes.

Sorption from pulps is of special significance for improving technology. With a filterless technological layout its intensity is 100 times higher than the results of the filtration methods previously employed, it has been possible, using synthetic sorbents, to concentrate a valuable component and separate it from the ballast ad-

¹ B. N. Laskorin. The Creation of Technological Processes Excluding Detrimental Effects of Industry on the Biosphere. Vestnik AN SSSR 1973, 9 27-31.

² Ibid.

³ Ibid., p. 28

mixtures, a method developed in the USSR in particular to separate uranium from natural waters, and reported at the Second General Conference on the Peaceful Use of Atomic Energy in 1958. A sorption-extraction technology has been successfully introduced to treat the gold-bearing ores of Murun-Tau. This had made the productivity of the Murun-Tau gold mines four times higher than that of advanced South African mines¹.

Sorption concentration methods are very valuable because they open up prospects of extracting useful substances from wastes, thereby dealing with two matters at once in a complex, namely cleansing the medium and obtaining substances needed by industry. An important role in this respect for restructuring production is associated with the plant kingdom. In the discussion at the meeting Prof Yu A. Zhdanov, rector of Rostov-on-Don University, for example, stressed the importance of developing means to obtain a variety of organic raw materials from plants, since plants are the only kind of raw material that can be renewed².

Partially cyclic processes play an important role at the present stage, for example effluent-free production that takes water once from the environment and is then able to use it many times over.

The continuity and cycling of production processes are becoming an urgent matter not only for industry but also for traditionally based farming, in which the wastes of stockraising ensured the productivity of crop growing. As a consequence of the increasing use of chemicals in

¹ Ibid., p. 30.

² Vestnik AN SSSR, 1973, 9 47.

agriculture, the latter has been becoming a major polluter of the biosphere in recent years (toxic chemicals and the residue of fertilisers get into drainage and run-off). As the well-known American ecologist Barry Commoner says, 'man has broken the cycle of life' and so caused the ecological crisis. He links its development also with overloading of the soil system:

The deterioration of the soil is a sign that the soil system has been overdriven, that organic matter, in the form of food, is being extracted from the cycle (i.e. the functioning of the tropic pyramid — *I. N.*) at a rate that exceeds the rate of rebuilding of the soil's humus.¹

The examples of overcoming the environmental crisis suggested are, it is true, extremely radical. Commoner considers that we should turn in general from the production and use of all artificial substances, guided by the extreme ecological principle that 'Nature knows best'. Such an ecological swing is unlikely to provide a solution to the problem—the real job is not to reject modern technology but to reconstruct technology so that it will not have a disastrous effect on the environment and man's health. The cycling of production and introduction of a continuous technology are an important trend for carrying through an ecological-technological revolution in the epoch of the scientific and industrial revolution.

Before we venture on a radical restructuring of any concrete technological process, of course, we have to weigh up whether it can be adapted to the laws of the biosphere by less radical measures, for the creation of a 'clean technolo-

¹ Barry Commoner, *The Closing Circle* (Alfred Knopf, New York, 1972), p. 123.

gy' is a very costly business, and there will not be enough funds for its full realization until the peace forces have achieved a real reduction of armaments. In general the creation of 'clean technology' is a complicated multi-stage process, and in carrying it out we cannot swerve from one extreme to another (for example, by simply replacing the slogan 'More DDT' by another 'Not a Gram of DDT'). In order for all measures for the ecological reconstruction of technology to be scientifically based, and their consequences weighed up ecologically, technically, and biologically, methodological restraint is needed.

The list of possible ways of restructuring production from the angle of the requirements of the objective laws of the biosphere could be continued, but what has been said allows us to draw conclusions about the complex and multi-dimensional character of the problem of optimizing the relation between technique and the biosphere. To resolve this problem we have to employ the elements of all rational trends in the ecological technological approach; at the same time not a single one of them should be abandoned as a universal technological panacea for dealing with ecological problems. For the foreseeable future links with technological traditions based on physico-chemical principles that will enable optimum relations between progressing technique and unchanging nature to be achieved in their rational treatment, will be decisive. In this

We can conclude that, for successful solution of the ecological problem it is not only important to abandon any one trend in the general transformation of techniques but it is also necessary to consider these transformations in unity with the possibilities of traditional technology.

intimacy of man and nature, and of allowing in human actions for the latter's possibilities

In order to overcome the crisis moments in today's ecological situation we have to develop the methodology of scientific knowledge further.

4.1. IS THERE AN ECOLOGICAL CRISIS OF SCIENCE?

If we understand by crisis an already established situation, then it would be more proper, in our view, to speak of crisis phenomena that could develop in the aggregate to the scale of an ecological crisis and even to its highest, irreversible form, ecological catastrophe. The essence of the crisis phenomena in the present ecological situation is thus the development, and a certain hardening, of conflict relations between man and nature, relations capable (if they are not combated) of carrying mankind to ecological catastrophe. One of the major contemporary problems of science and practice is precisely how this is to be avoided. The ecological crisis of science is expressed, in our view, in four main moments: the unexpected establishing of ecological limitations; the imperfection of a one-way movement of information that in essence ignores the feedback of technical links with the environment and with man himself; lack of information (informational-ecological hunger); the internal contradiction of the recommendations of separate scientific disciplines (interdisciplinary ecological blind spots).

1 Nature is ontologically and epistemologically inexhaustible, but the present ecological situation is evidence of her limited character on the ecological plane. The establishing of the s-

nature of the environment for each given of the evolution of its relationship with man incomparable in its fundamental character with idea of the inexhaustibility of the electron, as the physics of the beginning of this century managed to assimilate the conception of the exhaustibility of the electron only through a break-up of its notions, so modern science only, on the whole, be able to assimilate the idea of the finiteness of the environment—not much on the plane of resources as on that of finiteness of nature's assimilatory possibilities in relation to products of human activity that becoming more and more technical—at the expense of a substantial methodological reconstruction of itself.

Science on the whole has proved to be wholly unprepared for the new situation in the environment. That is not surprising, because it has been developing for centuries as a specifically human means of taming nature, and a means of achieving man's stability at the expense of a seemingly inexhaustible environment. Now, as has been said, new problems of harmonising man's relationship with the environment caused by her ecological finiteness are coming to the fore.

In the light of that, the following thesis of Lenin's is now becoming specially pressing:

The non-fulfilment of ends (of human activity) has as its cause (*Grund*) the fact that reality is taken as non-existent (*nichtig*), that its (reality's) objective actuality is not being recognised.¹

2 The disarray of science's transforming and forecasting functions is grounded in a one-

¹ V. I. Lenin, *Conceptus of Hegel's "Science of Logic"*. *Collected Works*, Vol. 38 (Philosophical Notebooks). Progress Publishers, Moscow, 1978, p. 217.

way flow of information along the line nature—science—technical effect—nature. The reverse scheme—nature subjected to technical action—man—is poorly allowed for. Suffice it to recall that the great discoverers of radioactivity did not suspect that it was lethal for protoplasm in certain doses; still less could they know of the radiation hazard to man's then little studied genetic system.

But now, given today's scientific and industrial revolution, chemists pondering how to create effective weed-killers and agricultural pesticides have not greatly interested themselves in how these substances, which do not occur in nature, will disturb her.

Scientific thinking was unidirectional, solely toward acting on nature and transforming her. But surely movement of scientific thought along lines with a feedback, that is to say, allowing for how technical action implemented on science's advice will reciprocally affect man himself, who has engendered science, is important for genuine control of the environment. Man has not yet, however, become the centre of all science's conceptions, as the determining criterion of optimization of the biosphere.

3. Furthermore, we can speak of a crisis in connection with the acute lack of scientific information about the interaction of technique and nature. Indeed, many types of information vitally important for man are lacking. Permissible doses of radiation were considered to have been ascertained, but as science develops they are being lowered. The permissible doses of toxic chemicals in the soil or water are much more poorly studied. And the quantity of foreign metals, say, or of asphalt, if the biosphere can somehow tolerate, is almost not being investi-

gated at all. Meanwhile, certain linear extrapolations yield a result that hard-surface roads will cover up to five million square kilometres in the world in the comparatively near future, i.e. of the order of half the area of the United States. Could the planet become overloaded with asphalt? The answer to that is connected with establishing biospheric criteria of technical development, but they have so far almost not been developed by science.

4. One can speak, finally, as well, of a crisis within science connected with the fragmentation of the various disciplines in research into the biosphere. It can hardly surprise us that the recommendations of the various scientific disciplines therefore lead to a state of contrariety, i.e. of mutual exclusion or incompatibility. As a result of this war of the sciences', everything that is damaged in the biosphere in our highly technical age is damaged on scientific grounds.

If we glance even briefly at the structure of modern science we will readily note that the leader of modern natural science—physics—is still little concerned with the problem of environmental pollution.

The late President of the USSR Academy of Sciences, M. V. Keldysh, quite justifiably stressed that solution of the problem of the biosphere must alter the direction of the natural sciences' development to some extent, because, under the impact of physics' advances carried over into chemistry and biology in recent decades, we have begun to approach nature from the angle of very fine structures and of investigating her conversion possibilities, and have forgotten what consequences that conversion involves.¹

¹ Vestn. AN SSSR, 1970, 6.46

With the present gulf between the natural and social disciplines it is extremely difficult, if not impossible, to take these consequences into account

It is necessary to unify natural sciences knowledge with social processes and at the same time to make the social imperative imparting motion to science more detailed and precise. For science, when it is the servant of the owner, easily proves the legitimacy of unrestrained chopping down of trees—it is extremely necessary to overcome that narrowly utilitarian approach to nature.

The natural-social synthesis comes out especially clearly in industry. Industry is aggressive in relation to nature, but it is also a continuation of nature. Science imparts motion to industry, but science should stand between industry and nature as a control mechanism, as a measure harmonising the 'man/nature' relation.

For 'natural science [to] lose its abstractly material—or rather, its idealistic—tenacity, and ... become the basis of *human* science',¹ it has to set broader aims in the initial principles of scientific knowledge than simply intensified growth of the consumption of matter, energy, and information. For its end should 'bind itself together with objectivity through a Means and in objectivity with itself'.² As technique (in becoming ever more powerful), is being converted from a means to an end in itself, we are getting

¹ Karl Marx *Economic and Philosophic Manuscript* of 1844. Karl Marx and Frederick Engels *Collected Works* Vol. 1 (Lawrence & Wishart, London, 1971) p. 213.

² G. W. F. Hegel *Science of Logic*. Translated by W. H. Johnston and L. G. Struthers. Vol. 2 (Allen & Unwin, London, 1927), p. 344.



the fragmentation of the scientific discipline which are continuing to divide and redivide

While not questioning the decisive role of the social aspects of the ecological problem, * must, at the same time, stress that the solution of this problem presupposes, on the methodological plane, a fundamental strengthening of the monistic principles of science. These have always underlain it as its strategic meta-axioms but of late their realisation in research tactic has been drowned by the nearly uncontrollable anarchy of the differentiation of knowledge, which sometimes has as its inevitable consequence, a contradictoriness of both scientific information and scientific recommendations that is acquiring a chaos creating character.

All that is due to the disconnectedness and contradictoriness of ecological information.

The complexity of the problem of the biosphere, alas, often presents its negative aspect to man, emerging as something that is disrupted both in knowledge and in material practice, and is even, for some writers, the limit in general of knowledge. Thus Commoner writes:

Moreover many of these air pollutants interact chemically, and their reactions are influenced by temperature, humidity, and light intensity. This leads to the dismal, but I believe realistic, conclusion that the detailed composition of polluted air is not merely unknown, but also unknowable to a considerable degree.¹

This methodological orientation borders on the agnostic extreme that in general denies the attainability of reliable knowledge in science. Experience indicates the unconstructive character

¹ Barry Commoner. *Op. cit.*, p. 76.

of this position—after all mankind has so far resolved problems however complex they have been. The extreme connected with the simplification categorical character of sometimes one-sided recommendations is no less dangerous. An erudite Soviet geologist has stated categorically:

I think our descendants would laugh at us if we began to save Siberian oil for the future and did not use it to hasten development of the productive forces.¹

Are there not elements of a narrow, departmental limitedness in so categorical an approach? At the same time forecasts made from the stand-point of isolated scientific disciplines often do not dovetail. Our geologist suggests that after 2000 all oil will be used for chemical synthesis and energy will be obtained from nuclear fission. But statements are made in physics that the Earth's reserves of fissile materials will be practically exhausted by then and will not be able to play appreciable role in mankind's power budget.

Illustrations of this kind of interdisciplinary incompatibility in modern science are emotionally very impressive, but it seems that it would be more constructive in the context of our theme to make a methodological analysis of the trends of development in science in connection with the ecological problem. With such an approach we first of all come up against an acute lack of information about the biosphere and the need to fill this gap. It is justifiably stressed in the present-day literature that we must guarantee the continuous gathering of information about the course of natural processes in natural areas.

¹ V. Vyshevsky. *Sibirsk. Oil. Khimiya i zhizn*, 1973, 8:7
² Ibid

regulating process, for research is both a *select* *process* from the whole host of factors' and a *selection* on the most essential ones (for ^a *research*). Allowing for that, however, it is *necessary* to increase the *influence* of scientific constructs continuing to regulate the *atmosphere* as a complex system.

The need for complex analysis of the possible number of factors is often example in study of the ratio of the *increase* in the amount of carbon *due* to the *rate* of its absorption by the leaves of

Woodwell and Wright carried out experiments with an increased concentration of carbon dioxide. They found that quantity of increase in the air's carbon dioxide *from* this observation, carried out by the special equipment developed by the Brookhaven Laboratory, it followed that the *subsequent* increase in the concentration of carbon dioxide (around 10 per cent), which began in the middle of the nineteenth century, has been an increase in the net production of plants *of* also around 10 per cent.

Citing these points, Woodwell just mentioned

Such simple single factor analyses of environmental problems, however, are always misleading. As the carbon dioxide concentration in the atmosphere has been increasing, many other factors have changed:

¹ *Carbon Dioxide in the Atmosphere*. *American Journal*, 227, 3-11, 1954.

Listing the main changes in the biosphere caused by man, he gloomily remarked: 'These are major man caused changes in the biosphere, many aspects of them are irreversible their implications are poorly known' ¹

Cloud and Gibor, analysing the oxygen cycle in the biosphere, state:

If we want to ensure that the biosphere continues to exist over the long term and to have an oxygen cycle, each new action must be matched with an effort to foresee its consequences throughout the ecosystem and to determine how they can be managed favorably or avoided. Understanding also is needed, and we are woefully short on that commodity ²

Much is unclear and indefinite, of course, in relation to the possible future environment, but the data already available are quite alarming, because there is evidence of a steadily developing replacement of higher forms of life on the Earth by lower ones through the effect of anthropogenic factors.

The evolution of an oak tree at the Brookhaven Laboratory, for example, as the result of continued exposure to gamma radiation, convincingly demonstrates the dangerous effect of the tendency toward an anthropogenic replacement of highly developed large forms of life (pines and oaks) by degraded local biota (sedge, grasses and herbs) ³

There is a moment of similar replacement in cities and cultivated lands, because the simplified

¹ Ibid p 74

² Preston Cloud and Aharon Gibor The Oxygen Cycle Scientific American, 1970, 223, 3.123. (My italics —J. N.)

³ George M. Woodwell art cit, p 66.

have the character of *ecological-technological revolution*. There will have to be a far-reaching technological revolution, obviously, in particular from industries that damage the environment to biospheric compatible processes in industry and agriculture. By accumulating reliable information on the basis of which fundamental changes will be made in all man's activity, and not just in production (although the development of technological improvements is, of course, the decisive factor in the whole system of measures), scientific character aimed at optimizing man's environment), science will acquire new methodological principles. The first such is that of ordering the accumulated information according to the near and remote consequences of technical man's effect on nature. We shall touch on this point again in the next section.

The second methodological principle of investigating the biosphere is connected with supplementing science by an *effective science of the possible*. Its application will to some extent alter the actual technology of scientific activity. Science used to work in the main by a two-member scheme:

- 1) to reflect what is in the object, irrespective of the subject's activity,
- 2) to indicate, on that basis, how to act further. Now the scheme has become more complicated as follows:
- 1) to reflect what may be done with the object with the appropriate form of the subject's activity (because the object - the biosphere largely depends on the subject's activity)
- 2) to compare and bring into line, the desired form of the object (the biosphere) with the activity needed for that form.

3) to indicate how to select the optimum (sub-optimum) action in given conditions, allowing both for the direct and the reverse links of the technogenic effects on the environment and for their consequences for man

Modern science should be unusually sensitive to changes in the biosphere. It should know not only what it is possible to do (under the known objective laws of nature) but also, and to an ever greater extent, what possible consequences our actions will have. This methodological requirement will generate its own forecasting style of thought. The most important indicator of the maturity of a scientific trend, moreover, will become the multi-factorial character and precision of analysis of the consequences for the biosphere of carrying out scientific and technical projects. To make the calculations more accurate, more profound knowledge of the real relationships is needed in turn. It is now justifiably remarked that, for lack of information, there is a lack, as a rule of accurate estimates of non steady biospheric processes, whereas there are approximate, rough ones in plenty, whose reliability is very uncertain. In discussions of a future electromobile (which would need a two- or threefold increase in the number of power stations to charge its batteries), for example (to take our earlier example further), it is perhaps necessary to calculate more accurately which will pollute the atmosphere more—the motor car or the increased number of thermal power stations charging electromobiles.

Mankind is at the threshold of cardinal decisions on which the fate of the planet and of ourselves depend. For those decisions to be optimal, a set of alternatives from which to choose is needed. An understanding of how long we

postpone the final choice of strategy in relation to the environment is also needed.

As regards the problems of overcoming adverse anthropogenic effects on the climate, Budyko justly stressed:

Although it would be premature to adopt the preliminary results we have obtained to plan economic affairs, they can be used to estimate the time in which it is necessary to obtain precise information of the climatic conditions of the future. Allowing for the data we cited above on possible rates of change of the climate, we must take it that *this period does not exceed ten years*. A later decision of the question of the climate of the future could make it impossible to take the necessary steps to avert harmful effects of the changes on the economy.¹

Information on the whole system of knowledge about the biosphere will help us orient ourselves more and more surely in the fight to preserve our planet's nature.

4.2. UNITY OF SCIENCE'S TRANSFORMING AND FORECASTING FUNCTIONS

Unity of science's transforming and forecasting functions is an important condition for optimising the biosphere. We have shown, in the course of our exposition, that this optimising is linked in the main with the optimisation of activity, which in turn has its material basis in a radical change in production processes, i.e. a technological revolution. The technological revolution, however, would not be one on the scale

¹ M. I. Budyko *Op. cit.*, p. 41. (My italics.—L. N.)

and technical plane unless it proved to be
closely interconnected with science.
Solving of the ecological problem calls for
strengthening the unity of these functions of
science. Science, which has accumulated extensive
material on mastering natural processes, has
proved less adapted to predicting the consequences
of these nature-transforming actions. In this
connection we have in mind science's active side and
its theoretical structure. While the scientific
approach is a synonym, on the theoretical plane,
of a forecasting approach on the resultant ec-
ological plane (i.e. in application of the results of
research to production), the scientific character
of the recommendations and the forecast of the
ultimate results of their implementation are far
from identical. Furthermore the task used not to
pose a forecast of a scientific recommenda-
tion's consequences for the biosphere and man
is not demanded of it. What is new in science's
modern forecasting function? For in itself this
function is a traditional attribute of the scientific
method. It is now not a matter of forecasting the dev-
elopment of the object in isolation from the sub-
ject, but of predicting the path of development of
the subject/object system, which depends to a con-
siderable extent on man's behaviour.

It is necessary to distinguish between forecast-
ing by laws and forecasting by the consequences
of behaviour (i.e. by an indefinite number of
natural and social laws). In purely scientific pre-
diction of the course of a process from scientific
theories either the direct useful effect is primarily
required or simply the condition that all pos-
sible adverse moments will be compensated by the
usefulness of the future. That natural hope is not
enough now. It is necessary not only to put the
scientific result into effect but also to take the

consequences of that into account scientifically, which modern science is not always capable of doing. Hence the disharmony in its development which is affecting the whole process of optimising the biosphere. Here is another paradox, that everything that is damaged in the biosphere is damaged on scientific grounds.

The disharmony between science's transforming and forecasting functions is reaching the scale of a dualism of sorts in the methodology of science. Only an organic synthesis of these two important functions can restore its monistic structure to science.

The disharmony, and even the rupture, between these functions is natural, and is the fruit of traditional science's directly utilitarian drive. Rational knowledge has always had to show us what we can master. Only now has the question been posed differently for the first time; the question of how things would be after this mastering and what we would pay for it used to remain in the background. Or rather the adverse, consequences were admitted *a priori* to be something immeasurably smaller compared with the positive achievement. Not knowing the nature of fire, ancient man burned himself of course, but he very quickly concluded from that not that it was necessary to reject campfires but simply not to thrust ones hands into it.

In today's ecological situation of scientific and technical society that kind of half-instinctive allowing for the consequences is of course, quite inadequate. A scientific procedure for closing the chain is needed to allow for the consequences of the consequences for man.

The environment, which was traditionally conceived simply as a limitless reservoir of opportunities for man's behaviour, is becoming a kind

multaneous development in both the object and the model. It is essential, therefore, for the model to develop faster than the object. The guarantee that the object will repeat the path taken by the model in its development (i.e. that the object will 'reflect' the model) is the common character of the laws of development, in the basis of analysis an objective generality, the basis of which is the world's material unity. The structural invariance of the laws of development of the object and the model is the basis of forecasting modelling prognostic simulation.

Any prognostic model (like any informational structural system) develops in fundamental unity with the external world and by the same law. That is why a given model of itself reflects the possible development of the real world sometime in its development. The model's hypothetical development up to a certain moment in the future is also a process of forecasting.

It is particularly essential to build forecasting models to study climatic changes some of which may be of an anthropogenic character.

Back in the 1950s I. Vgony Fedorov, then head of the Soviet meteorological service, remarked "We risk discovering essential, maybe undesirable, changes in the climate, difficult to correct before we learn to predict them in good time".

Simulation of the future consequences of future shaping activities not yet completed puts itional limitations, above all, on human activity encouraging its optimisation according to the biospheric consequences, but at the same time it provides great freedom (in the sense of great variability) of human action. For, knowing the

consequences, we can select actions according to their consequences. That is possible because mental research activity, i.e. modelling, unlike spontaneous natural processes and production procedures, is reversible.

In an interlude in Samuel Marshak's dramatisation of a well-known fairy tale, we meet a good old man and an evil one. The former gives the latter the right to tell the whole story in his own spiteful understanding of it; only the good old man will tell the ending himself, so as to wind up the whole business happily, and not upset the children. The nasty old man, including the old story-telling refrain 'Stay away from goat's horn, eye and knives' in his part of the tale, venomously addressed it to the good old man who was to end the story happily without upsetting the audience. But in romantic fairy tales Earth's prosaic laws of irreversibility do not operate, and we can quite easily perform an unusual wonder by means of an ordinary sack—'recover from knives, eye and goat's horns'.

In modelling (as in fairy tales!) we can reverse the process of deterioration of the biosphere (Kenneth Watt investigated a model of the optimum culling of buffalo [bison] a century after their rapacious slaughter in the United States¹). We can thus, in reconstructing time connections and passing theoretically from the consequences (future) to the actions (present), choose the optimum action.

It can be concluded from what has been said that we do not pass from the present to the future but rather from the future to the present, this future being a reality in the present given in

¹ Kenneth E. Watt. *Ecology and Resource Management. A Quantitative Approach* (McGraw-Hill, New York, 1963), pp. 358-61.

the model. This reality also determines the objectivity of the forecasting information.

The problem of forecasting comes down, as we see, to one of building a model of development. The simplest are models based on extrapolation used in practice in scientific and technical modelling. The extrapolation technique however, is quite inadequate for constructing statistical data-processing forecasting models. We may also mention the flooding technique, optimum coding technique, and morphological analysis; it is possible that other techniques will be developed (not only based on statistical information theory but also realised by non-statistical approaches to data).

The development of these techniques is itself evidence that quantitative and qualitative analysis of the whole mass of contemporary scientific and technical information has now become of paramount importance.

In a certain complex, dynamic, data system, feedback is established with its future states at a certain moment in its development, which in principle increases its stability in its development. Living organisms ('advanced reflection' in Anokhin's phrase cited above), or even society as a whole (forecasting as a social function) can be taken as examples of such systems.

We may thus infer that scientific and technical forecasting is, in a certain sense, feedback with the future based on scientific prediction and designed to increase the stability of both human society and the medium in which it exists.

The stability of a system is increased through chains of self-management, from which it follows that the forecast data must be fed into the control system. The functional link between forecasting and management is obvious.

ning. The aims are formulated by the director before implementation of the general aims is then ensured by carrying out more detailed partial tasks or sub aims. The ordering and general coordination of aims and sub aims, and their distribution in order of importance is taken in graphic form ranking takes the shape of a branching figure (tree of aims).

The plan in turn affects forecasting, pricing it tasks. There is thus a complicated interaction of plan and forecast in a single process of forecasting within the system of management or control.

There is a definite relationship between the proportions of the theory of the control of chaos on the basis of goal criteria and the theoretical conceptions of forecasting (prediction of consequences).

Formalized explication of the forecasting data, which are raised to the level of a qualitative description of the next links, has an immense role in this respect. Unity of the transforming and forecasting functions of science is most effectively realised on the basis of the tendency of applying mathematics to knowledge, which has obtained a methodological catalyst in the form of systems approach. V. A. Steklov, who, as Vice-President of the USSR Academy of Sciences, worked out a programme for the development of Soviet science, once said to Lunacharsky, developing Leibniz's profound behest not to dispute but to reckon:

People will certainly all agree among themselves, and on all matters, moreover, but that will only be when the science of nature, i.e. all truth, has been formulated mathematically.¹

¹ A. V. Lunacharsky. Obituary of V. A. Steklov. *Vaska gazeta*, 1 June 1925.

stability, which reveals the mechanism of system's attitude in their medium.¹

Self-organising systems are ones possessing flexible criteria for differentiating random signals and flexible reactions to effects. They can adapt themselves to previously unknown signals and effects. Constant self-reproduction guarantees these systems a certain stability.

Adaptation of hitherto unknown signals and effects we can call an embryonic form of forecasting. The following example is characteristic: the chrysalis of a parasitic wasp, forced to overwinter in the open air, quickly develops glycerine in its protoplasm with the first autumn cold snaps (down to -5°C), which considerably lowers the cryoscopic temperature of the cellular mass, which helps it subsequently to survive frosts as severe as -70°C .

At a certain level of complexity the capacity to adapt to previously unknown effects grows over into a capacity to foresee these effects, i.e. to make them to some extent known in advance.

In this case we speak of predicting systems. As will be evident, feedback from the future emerges at the level of these systems, i.e. a certain stable and regular form of forecasting. Predicting systems have memory of a capacity that enables them to predict certain future situations on the basis of accumulated experience, based on the regularity of their appearance in the past. Examples are higher animals and man.

The highest type are systems not connected with permanence of the material carrier of their stable structure. Such a system is called transforming

¹ V. A. Kotelnikov *Teoriya potentsial'noi pomekh sostochivosti* (The Theory of Potential Noise-Proof Capacity), Gosenergoizdat, Moscow, 1956.

they are put in action. Information is added to realization there otherwise they may be accumulated practically infinitely by virtue of which the realization changes mounting without restriction it will lead to a qualitatively different biosphere.

It is important to forecast the hazards of a transition via infinity (or through infinity) leading to a deterioration of the quality of the environmental component of the biosphere. For we are observing dangerous symptoms of a transition from an environment developing in a proanthropic direction to one taking an anti anthropic path that could prove to be the brink of destruction of all forms of life (more complex than insects). The transition through infinite accumulation of wastes is a form of losing the biosphere's qualitative definiteness, a form of transmutation into something opposite.

Engels, discussing the development of incommensurability in geometrical objects into infinitely large and the infinitely small (in the sense that a straight line can be considered a circle with an infinite radius), wrote: 'Here it is the difference in quantity of similar magnitudes that increases the difference in quality to the point of incommensurability.'

The transition via infinity transforms quantitative difference into a qualitative boundary that is overcome at the price of eliminating the phenomenon—a circle becomes a straight line (when its radius is infinite), the biosphere is converted into a qualitatively different system with degraded biogenic components (if the wastes

¹ Frederick Engels *Dialectics of Nature* (Progress Publishers, Moscow, 1974), p. 250. See also *Ibid.* (Lawrence & Wishart, London, 1910), p. 210.

be a matter of time before steam would be the prime source of power on the farm it would have been difficult for them to avoid the conclusion that the horse and male population would decline rapidly.¹

The division into 'economists' and 'technologists' in today's problems of forecasting is obviously no less important than the once customary classification of scientific workers into 'classical' and 'romantics'.

But it is not a matter of being ironical, from the heights of the 1970s about the conservatism of the classical science of the nineteenth century, divided into separate compartments. In present-day discussions about the significance of modern science and technique it has become a kind of cliche to state that science's significant achievements of the next stage have so far proved immeasurably more powerful than those of the preceding one. The classical technology of the last third of the last century, for instance, could not envisage the need to take the internal combustion engine into account. And classical power engineering were still continuing by inertia to plot attenuated curves of a shortage of energy reserves when Fermi and his colleagues were building their uranium-graphit pile under the stands of the Chicago University stadium with titanic perseverance.

It seems to us, however, that a direct analogy with the past will not do in respect of the science of the second half of twentieth century. This is linked primarily with the immeasurably greater maturity and integration of modern physics. The main point now is not that we are unable to imagine some 'gravitational-photon-

¹ Harrison Brown, *Op. cit.*

For instance, the possibility of a kind of return to a stone age is now being discussed (obtaining the mass of energy needed by man, for example, from granite). Harrison Brown says that

a ton of granite contains easily extractable uranium and thorium equivalent to about 15 tons of coal, plus all the elements necessary to perpetuate a highly technological civilisation.¹

Man's power would be made even greater in that case. Brown limited himself simply to the general comment that this would give rise to new problems. Orienting himself, however, on the conformist presumption of 'happy endings', he concluded that

per capita energy consumption would come to the equivalent of perhaps 100 tons of coal per year.... The world would be quite different from the present one, but there is no reason *a priori* why it would necessarily be unpleasant.²

On the plane of our theme it would seem that Brown himself falls into a narrow professional illusion in this pantechnicist idea, an illusion based on an unwitting substitution of integrated synthetic information about the environment for partial, differentiated information applicable only in allowing for certain factors of being. Transition to a 'granite' technical civilisation would undoubtedly face man with an acute problem of technogenic overheating of the planet.

The biospheric aspect of the second law of thermodynamics is associated with the discovery of fundamental limitations both to the obtaining

¹ Harrison Brown. *Op. cit.*
² *Ibid.*

sible consequences of their biospheric transforming acts.

A neo-ordained force is the worst form of man's weakness in the epoch of the scientific and industrial revolution.

Such a powerful form of optimising the biosphere is the main enemy of a genuine, substantial optimality in the inter relations of man and the environment.

A second important aspect of the 'science of impossibility' problem is connected with the limited character of the forecast.

Laplace, one of the founders of classical mechanics, taught, as we know, that if we could know the initial conditions and equation of motion of any system exactly, we could unequivocally predict its behaviour at any moment of time.

In reality, however, (even leaving aside the statistical laws of the microworld discovered later, and perhaps the laws of classical physics too,) such a precise rule was unrealisable at every step in practice because of the complexity of determining the initial conditions. And the more remote the time, the more this initial, originally hardly noticed, error will make itself felt.

This circumstance has given rise all the time to the hazard of a breach between the goals of the results of man's actions, and has limited the possibilities of optimising effects. For, as a matter of fact, our remote predecessors strove to optimise production from their first steps to develop it. Their experience must be allowed for. As the ninth century Buddhist thinker Kobo Daishi, known as the Great Teacher from the South Mountain, said 'Do not follow in the foot steps of the ancients, but seek after what they sought.' His idea is also applicable to questing the conditions of optimisation.

nature accessible to us forms a system, an interconnected totality of bodies."¹

So the favourite object of astrological speculation, the dependence of men's lives on the stars, also has a place? Generally speaking, this is not excluded. But then where is the line between science and pseudoscience? We ask the reader to accept that this question is not a simple one in all its theoretical niceties, and still limit ourselves here to the conclusion that the following criterion can be considered adequate for practical purposes: if there is a link between the stars, planets, and people, it is insignificant to vanishing point, and so essentially insubstantial, and therefore cannot serve as the subject-matter of a rigorous science.

In many cases it is probably easy to ascribe the cockiness of some of them to the fact of their birth under the sign of Mars (or to some other arbitrarily interpreted sign). But even if such a co-incidence in time, or as they say, correlation, were substantiated, it proves nothing.

The American scientist Kinsman, sharply refuting the technique of statistical demonstration of a dependence of the climate of Florida on the icebergs of the Atlantic, calculated the correlation between the number of icebergs over ten years and the number of commas on ten successive pages of the work he was discussing. The correlation obtained was 0.81; consequently, by the logic of the addicts of statistical juggling, commas were the cause of icebergs.

Thus the paradox of such conclusions, and their unsoundness, will be apparent. But the question remains whether there is, in fact (ir-

¹ Frederick Engels. *Op. cit.*, p. 70

ecological crisis connected with environmental pollution is a partial variant of the universal mechanism of the transition from quantitative changes to qualitative ones. While the mechanism of this crisis emerges as a cumulative process, the crisis is linked content-wise with capitalism's intensified plundering of natural wealth (especially of the so-called renewable products of the biosphere), with the need for a radical transformation of the technology that gives rise to a mass of wastes, and with science's unpreparedness for the new situation in the environment, in which the strategy of mastering nature has revealed its limitations.

A system with feedback is more complicated, and it is difficult to analyse its possible future behaviour. Because of these difficulties a tendency toward a kind of predictive agnosticism is developing in Western literature that in general justifies the impossibility of a rational representation of the future such as would have some, in any way reliable, significance for controlling human actions in the present.

The question 'what will be?', understood traditionally in the spirit of what will not contradict nature's objective laws, independent of man (i.e. what is natural), has acquired the specifically human context (and in that sense has become subjective) of 'what may happen as the result of human activity?' Science's reflective or contemplative (transformatory) function has revealed the disparity with its prognostic function. In order to eliminate this disparity science must become a theory of possible worlds (in man's action) as well as a theory of the really existing world. Then what will be? will yield an ever greater area of the information able to



We can conclude that, however developed science is, and however high the pinnacles it has reached, it is not able to survey all the consequences of all effects on the biosphere and for all the ship of science must not be overloaded with excessive hopes, because these, if not coming true, may sink together with the helmsman. New actions optimising the biosphere will entail new, unexpected consequences, which will call for new forms and methods of optimising the biosphere.

Thus, it is impossible, at any level of science, to discover some kind of absolute biosphere-optimising act, optimising the biosphere is not a once and for all campaign but a contradictory process that will never cease so long as there are people.

The nature of this process is social so that its outcome ultimately depends on the future of social progress, namely on the transition on a world scale to a planned economy on the basis of social ownership of the instruments and means of production. An important stage on this road is the international co-operation of all countries to protect the environment proposed by the Soviet Union. Science, however, is called upon today to prepare the theoretical basis of that future real harmonisation of the interaction of society and nature, integrating itself into a strategic solution of the ecological problem such as would exclude an irreversible and final environmental catastrophe (or state of ecological collapse).

5

ECOLOGICAL SYNTHESIS, THE FUTURE OF SCIENCE

A scientifically substantiated solution of the ecological problem necessitates a unity of economic, political, legal, ideological, and educational measures with integrated scientific and technical developments, because even the most humane organisational measures to protect nature can turn against man and mankind without comprehensive investigation of the mechanisms of the interaction of technique and the biosphere.

This issue is especially important for planning socialist society. Leonid Brezhnev has said:

A comprehensive systems approach to the working out of responsible decisions is needed. We have adopted such an approach and will carry it out consistently.¹

The multilevel social and natural science problem of optimising the biosphere has a methodological kernel connected with the task of integrating the sciences more effectively, for a measure recommended by one scientific trend, taken out of context of the whole complex, can in fact lead (and often does) to a clash with the recommendations of other sciences. And as a result it does harm.

¹ L. I. Brezhnev Speech to Voters of the Baumana Constituency, Moscow, 11 June 1971 *Leninetskim kursem*, Vol. 3 (Politizdat, Moscow, 1973), pp. 334-35.

There is no doubt about the need today for an integration of knowledge of nature, man, and their interactions, but the meeting of this need is largely limited simply to an interaction of the methods and findings of the different sciences, that not only preserves their sectional independence but also consolidates their internal conceptual exclusiveness in the course of this external interaction. Scientific language thus remains polyfundamental, while integration of the sciences emerges mainly as a scientific and organisational measure to unite various scientific divisions in one scientific enterprise.

While not questioning the productiveness and methodological justice of this form of integration of the sciences, we consider it a 'weak' synthesis of knowledge, serving as a premise for a 'strong' synthesis. The species of nature will find conceptual as well as organisational unity in such a 'strong' synthesis. The process of achieving it, of course, will include many controversial moments. It is a multilevel and a multistage process and it will probably not be wholly completed but will exist only as an uncompleted tendency, but there is no doubt that a unification of physics and the systems approach will be decisive in realising it (in whole or in part). In other words a 'strong' synthesis of knowledge will emerge more and more as a radical 'physicalisation' of knowledge of nature.

We have broken nature down into bits in order more conveniently to tame her, setting the bits against one another so that the combined effect would be profitable to man (Hegel linked that with the cunning of reason!) The

¹ See. William Wallace *Hegel's Logic, with Preface and Commena* (Clarendon Press, Oxford, 1893-4).

the need to overcome the emerging ecological crisis is creating an additional material motive for looking for more effective ways and means of integrating modern scientific knowledge.

A definite scientific revolution is called for, linked with reconstruction of the very logic of science. As Barry Commoner has remarked:

The controversy centers around the question of whether basic science ought to be pursued for its own sake, or whether equally basic research can be done in the complex arena of nature as it exists outside the laboratory.¹

The inner logic of the development of scientific theory—the drive to penetrate further and deeper into matter—is leading in fact to a discrepancy with the need of the vehicle of science itself, namely man: this moreover, is not a refined need of some sort, but a grossly palpable need to survive in a technically reconstructed environment.

Science seems to be going through a process of alienation from man, and in order to end the trend a re-orientation of basic science from problems of the depths of matter to those of the interaction of man and nature is needed. That applies above all to physics, which is being increasingly ecologised, requiring deeper analysis of both the biosphere's biogenic and abiotic parameters and their dependence on technical effects. The physics of animate matter above all needs to be studied in more detail. There are Alpine plants, for example, that have the capacity to transform solar energy into heat that

¹ Barry Commoner, *The Closing Circle* (Alfred Knopf, New York, 1972), p. 90.

tiple in research into the biosphere, relatively independent of 'physicalisation'. This separation from physics is linked with the systems approach's definite methodological limitedness; in combining processes and phenomena into complex sets, the systems approach, not yet permeated by physics, as a rule gives a functional description of the external phenomena of biospheric processes, necessarily abstracting them from their inner content and from the physical mechanism governing them. We shall touch on the systems approach's methodological merits later; now we shall look into the methodological nature of the elements of the 'physicalisation' of biospheric research already materialising today. Disciplines like geophysics and physical climatology are based on the method of physical deduction.

Budyko emphasises that

the main task of physical climatology is to develop a theory of climate so as to explain the patterns of a meteorological regime by the method of physical deduction,

i.e. on the basis of general physical laws.¹

Deduction of the behaviour of the biosphere on the basis of physics is also exceptionally fruitful in the sphere of developing a thermodynamic conception of the biosphere that demonstrates the complete applicability of the second law of thermodynamics to the biosphere.²

Thus, in our view, the most natural way of synthesising knowledge of the biosphere, and at

¹ M. I. Budyko, *Fizicheskaya klimatika* no. 4 (Man's Effect on Climate) Gidrometeorostat, Leningrad, 1972, p. 5.

² See G. Khil'm, Modern Conceptions of the Biosphere in [R. Novik et al (Eds.)] *Metodologicheskie voprosy issledovaniya biosfery*, Nauka, Moscow, 1974.



the same time the most radical (uniting all the sciences with physics) and most traditional (the spread of physics to new fields), is the generalisation of physics. The deduction of chemistry from microphysics already accomplished, and the integration of biology and physics being successfully carried out, favour this view.

If we accept this line, the reasonable question arises whether there will be this generalised integration of science by physics, for it presumes taking into account the experience and advances of all the branches of modern natural science.

The etymological argument above all favours this view, the title of Aristotle's *Physics*, for instance, comes from a Greek root *physix* sometimes translated by the Latin *natura*.

The book itself begins with a thesis in which physics is clearly identified with the science of nature:

In so far as knowledge and science are produced in all kinds of research involving principles or causes or elements, it becomes clear that in the science of nature it is necessary primarily to define what is related to principles.¹ (My italics.—I. N.)

The possibility of developing a single, universal physics in accordance with the law of the negation of the negation as the theoretical basis of all knowledge of nature is, in our view, quite real. This position would be the highest expression, the apogee, of the tendency to subordinate knowledge to physics that is observed in one form or another in our time (mitigated or more sharply). 'Physicalisation' thus emerges in gen-

¹ Aristotle *Physics* Moscow, 1936, p. 5. (In Russian.)

eral as a process (tendency, demand) of broader and broader extrapolation of developing physical knowledge to the whole sphere of the investigation of nature rather than as a once-and-for-all act of reducing the whole diversity of natural scientific knowledge to already existing physics. The process includes a feedback moment, that is to say all non-physical natural scientific disciplines are not simply being absorbed by generalised physics as the general theory of nature but are all making their contribution to this integration theory. Through knowledge of animate nature, for instance, physics is being 'biologised'. But since the conceptual basis, the starting point, of this universal synthesis is physical knowledge, this radical form of integration can quite justly be linked precisely with 'physicalisation' as extrapolation and at the same time generalisation of theoretical physics. Evidence in favour of this alternative is the transformation of theoretical chemistry into a branch of theoretical physics. One can suppose that a theoretical biology, too, will ultimately take shape as a certain branch of generalised theoretical physics that does not negate the specific nature of the animate, but expresses it as a kind of physics of the living.

Relatively independent branches of science will correspond to the specific fields of nature, but they will have a common theoretical physics, the departments of which will pass into one another on a principle similar to that of conformity. The single trunk of the tree of science, while remaining ramified, will consist of generalised theoretical physics and its divisions.

At the same time the independence of the divisions of research will be preserved (without their being isolated) within the framework of

phenomena At the same time it allows for qualitative ecological laws (of the type that a trophic chain is stronger the more links it has)

5 During 'physicalisation' of understanding of the biosphere, physics itself will undergo reconstruction, if not on the plane of its fundamental laws and constants, at least on that of its methodology. Physics must become evolutionary and systemic. Investigation of the structure of a phenomenon will thus organically merge with study of its genesis: in the end a single physicalist conception will be built of the evolution of matter from the 'big bang' (moment of time $t = 0$) to the present-day technicised state of the biosphere.

III. In addition to the trend toward 'physicalisation', the informational-systemic notions associated with cybernetics are acquiring a more and more essential role in optimisation of the biosphere. In their light man and the environment do not have the status of a taxonomic series or are even in a state of mutual exclusiveness and hostility, but form part, on the contrary, of a maximally broad system as information-exchanging internal elements (or rather, sub-systems). This cybernetic sociobiogeosystem has a capacity for self-regulation, while its elements (man and nature), taken separately, largely lose their capacity of self-regulation independently of each other. On that plane nature emerges not simply as something external in relation to man but as an internal condition of his further progress. Man and nature prove to be sub-systems of a universal sociobiogeosystem. Human progress can be seriously damaged by regressive degradational tendencies in the development of the environment

monobasic, that is to say, that physics underlies all understanding of nature in all its differentiation, while all the other sciences rest on physics.

That also holds in relation to the forecasts of the social sciences, which are not efficiently made unless they allow for the physical aspects of the matter. Science, for instance, has established that, as a consequence of technical development, the use of ever greater quantities of energy in production, transport and everyday life is leading to anthropogenic heating of the planet. The notion of a 'heat barrier' is arising, the breaking of which would irreparably alter the planet's climate,¹ for according to the second law of thermodynamics it is impossible to employ energy without disseminating heat, i.e. without heating the environment.

The idea of a heat barrier leads to the conclusion that we may have a finite quantity of energy at our disposal in any conditions of technical power (even with industrial mastery of thermonuclear power). The upper limit of changes in this quantity will have to be determined. It is quite understandable that possibilities of economic growth will be associated with it. In other words, when we allow for the heat barrier, we come to the notion of civilisation's physico-social parameters. Such economic forecasts must thus be based on information from the realm of physics, and not only, say, of geology, which estimates natural resources. For there is a danger of the heat barrier's being already reached within the next hundred years.²

In order to exclude the possibility of a discordance of physical and social parameters, a

¹ See M. I. Budyko, *Op. cit.*, p. 37

² *Ibid.*

ties of the environment are engendered by technicised man himself. In contriving to fight nature and losing his sense of proportion, man risks doing himself down.

In his *Philosophy of Nature* Hegel treated the 'cunning of his reason as man's capacity to preserve himself in face of the forces of Nature, by sheltering behind other products of Nature'.

That thesis undoubtedly covers one of the essential features of man's attitude to nature based in technique, but in our age many old truths characterising the interaction of man and nature, have revealed their limited character inasmuch as they were oriented on strategy of mastering the habitat. On that plane the technique of setting the forces of nature against one another has often proved, in fact not to be the 'cunning of reason but a naive dodge of the conqueror, who is incapable when pillaging, of thinking of reproduction. This cunning, based on crude force, proves in the end to be only a smoke screen for weakness.

The epoch of scientific and technical power supposes a different 'cunning of reason', namely a capacity for a comprehensive view of natural forces and man's rational action harmoniously with its biospheric consequences.

For our reason to be really 'cunning' (in Old Slavonic the words *khifru* 'cunning' and *umnyj* 'clever' were one concept²), we need not simply to set the forces and laws of nature against one

¹ G. W. F. Hegel, *The Philosophy of Nature* (Part II of the *Encyclopaedia of the Philosophical Sciences*) Translated by A. V. Miller (The Clarendon Press Oxford, 1970), p. 5.

² The English word *cunning* in its old sense of 'learned' comes from Old Norse *kunna* from *kunna* 'know — Tr.'

up other but also to foresee the consequences of that for man himself.

The methodological condition for such comprehensive vision is the integration of knowledge. Recognition of the need for a new deeper synthesis of the sciences in connection with the problem of the biosphere is often identified with a programme of rigid reductionism understood as literal reduction of the complex to the simple. Commoner, for instance, says, as regards forecasts of the development of science:

If such new technologies, which would necessarily cut across the narrow lines of present scientific disciplines, are in demand, we might expect scientists to overcome their reduction bias.¹

Reductionism is opposed precisely by systems engineering. The most fundamental difficulty of modern science, is linked, in fact, with a rational synthesis of physicalisation and systems ideas.

In his famous paper on ecology and social action at the School of Forestry and Conservation of the University of California, Commoner considered the prime cause of crisis phenomena in the biosphere to be the fact that in a disrupted ecosystem the natural cycle is converted from a circular system to a linear one.² But in our view he drew a mistaken conclusion from this just methodological thesis, as follows:

In an intact, natural ecosystem, the concept of causation is fundamentally meaningless. This is due to the circularity of ecosystems. Causality is a property

Barry Commoner, *Op. cit.* p. 228.

... Commoner *Ecology and Social Action* (Univ. of California, Berkeley, 1973), p. 11.

of a linear system, in which event A determines (is the cause of) B, B determines C, and so on.¹

It will readily be seen that the epistemological root of this methodological error lies in the author's ignorance of the dialectical interpretation of the conception of causality as an interaction. For that reason, by orienting himself on a metaphysical interpretation of linear causality he comes to a kind of ecological indeterminism. And in any case basic science cannot be extended to ecosystems with such an approach.

But it is not simply a case of that, for man does not develop (in contrast to wild ecosystems) in a closed circle, the law of human being in progression, progress Commoner's conception, as we see, assumes reducing man to the level of nature. So the theory of the closing circle proves to be inconsistent, and its consistent adoption leads to a kind of ecological Rousseauism, i.e. a turn from technique to nature. For all the critical strength of this conception (in relation to present technology and the system of private enterprise), its positive programme proves quite meagre. There are no grounds for confining man uncomplainingly to a closing circle. The main difficulty consists precisely in finding the means to combine the closing circle of ecosystems optimally with man's onward development.

It is possible in principle to combine the subordinate element of cyclicity with the leading tendency of irreversible progress, but progressive development must be represented for that in the form of a rational hierarchy of cycles so that it acquires the features of wholeness. The methodological basis of this is the achievement of integrationality.

¹ Ibid.

city of scientific staffs) is of the natural sciences and social compartments.

The practical orientation of the concept of a sociobiogeosystem is connected with a slight shift of activity.

The integral interdisciplinary character of research into the biosphere is the basis of the ecological problem that in our day will, on the one hand stimulate that powerful flow from the individual to social sciences of which Lenin wrote,¹ on the other hand it can only be solved on the basis of a more organic synthesis of the natural and social sciences. Commoner justly notes:

The environment is not a concern, which already range from the physical sciences, through biology, to engineering, technology, and demography, enter the even more controversial reaches of economics and political economy.²

The sociobiogeosystem can only be comprehended on the basis of a uniting of the efforts of specialists in the different branches of the natural and social sciences. Man comes into this ultracomplex system as the controlling sub-system and nature as the controlled. In the scientific and technical age earthly nature is largely losing the property of self-regulation and is beginning to depend to an ever greater degree on regulating activities by society. The fate of the sociobiogeosystem is largely governed by social laws.

¹ The complex character of the ecological problem is demonstrated in the group work edited by I. N. Novik et al. *Metodologicheskie aspekty issledovaniya "losifery"* already referred to.

² V. I. Lenin *Collected Works*, Vol. 20 (Progress Publishers, Moscow, 1964), p. 196.

³ Barry Commoner *Op. cit.*, p. 251.

“the use of natural resources and defence of the environment must also do their job.” This kind of work is truly national in the USSR.

Complex systems quite understandably presuppose a certain structure of interdisciplinary relations.

The foundation of this structure is a common methodology in the various techniques of concrete work. The strength of the reciprocal penetration of the sciences depends on the effectiveness of this integrating methodology. The theoretical basis of organisational completing is a certain preliminary conceptual generality (provided, for example, by the concepts of systems analysis) of the various sciences studying one single object, the biosphere. The integration of knowledge in the simplest form (exchange of information between sciences) anticipates completing, but the latter at the same time intensifies the theoretical integration of the sciences and wipes out the boundaries between them.

The completing of research is the practical basis for the integrating of the sciences, and the various sciences are becoming progressively integrated, moreover, in the crucible of modern quests for the truth.

Thus, although the complexing of the sciences must be distinguished from their theoretical synthesis, it nevertheless lays a foundation under the ever closer unity of the various disciplines (the highest form of which in the natural sciences is, for example, the trend toward ‘physicalisation’).

As regards research into the biosphere completing of the natural and social sciences should open the road to their deeper theoretical integ-

¹ *Pravda*, 21 September 1972.

ration on the basis of a general criterion of effectiveness, i.e. the effectiveness both of man himself and of the interests of his development. In the comprehensive applied development of big projects the natural and the social sciences may often be integrated through the technical sciences.

The Soviet philosopher Kedrov has remarked that the social and natural sciences are united with one another through technique and through the technical sciences.¹ Integration un doubtedly has its own meaning and it is found its place here but it seems to us that the decisive methodological role in this higher scientific synthesis will be played by the concentrative synthesis (as we have said the closure on of research (as we have said the closure of all scientific information) on the problem of man and the influence on him of the effects themselves caused by him in the environment. This general trend of knowledge had already been noted by Marx in his early work *The Economic and Philosophic Manuscripts of 1844* in which he wrote

Natural science will in time incorporate into itself the science of man, just as the science of man will incorporate into itself natural science there will be one science.²

The theme of the interrelation of the natural and social sciences is a broad one and we are only stressing a conclusion important for our exposition. One of the epistemological roots of the consequences of technical progress harm

¹ B. M. Kedrov. A Propos - the Synthesis of the Sciences. Voprosy Filozofii. 1971. I. 85
² Karl Marx and Frederick Engels. Collected Work. Vol. 3 (Lawrence & Wishart London 1973) p. 304

ful for the biosphere is undoubtedly the extreme division of labour which the current scientific and industrial revolution has perhaps made even more acute. The narrowly specialised engineer designer, for example, absorbed in concern for only some physico-technical indices, as who does not properly envisage the carcinogenic effects of exhaust gases, is not modern. The need for comprehensive, synthetic criteria has matured in technique in relation to which efficiency will be only a component.

Technical designing, as we have already remarked, needs to be subordinated to the criterion of the 'biospheric compatibility' of the projects being developed. An important means of optimising the biosphere is to reject projects that are noxious. Biospheric criteria of the development of technique are playing an ever increasing role in the epoch of the scientific and industrial revolution.

A synthesis of the natural sciences, the highest expression of which is the 'physicalisation' of knowledge, is a necessary but inadequate methodological condition for optimising the biosphere. The tendency toward synthesis cannot help moving on into the social sphere.

Marxism-Leninism, as an aggregate of economic, philosophic, and socio-political views, was and remains the foundation of the Communist outlook on the world. In addition, now in the age of the scientific and industrial revolution, especially under developed socialism, a truly scientific world outlook is inconceivable without its organic incorporation of the latest, generalized, philosophically comprehended facts of the natural and technical sciences.

Integration of the social and natural sciences can be based on the comprehensive concept

of a sociobiogeocsystem it will be brought about in two forms

(1) The first way is through the introduction of value aspects into scientific research. The methodology of quest after truth will more and more incorporate an axiological moment. Unidirectional truth, oriented on the depths of matter, is becoming two-dimensional, as it were, oriented on choice of the direction that in the given conditions will best serve man's interests. In that the value orientation of science will function as a methodological category enabling not only the degree of reflection of reality to be taken into account but also the degree of predictability of the consequences of applying theory.

The monism of dialectical materialism opposes the metaphysical splitting of methodology and axiology, the unity of methodology and axiology, on the contrary, emerges in modern ecology, on the contrary, emerges in modern conditions as an important expression of the unity of nature and society. Socioecogenesis itself is thus considered a single natural historical process with a universal tendency toward progress and the establishment of common higher forms of men's being all over the world. Dualist and pluralist extremes in dealing with the ecological problem only capable of obscuring the form of men's relationship and of man's attitude to nature.

The paradoxes of the present day scientific and industrial revolution are evidence that scientific knowledge alone is inadequate to achieve universal progress. It does not follow by any means from that, however that it is legitimate to supplement scientific knowledge by some kind of 'semi-pietistic, ethical anti-knowledge'. As certain capitalist 'futurologists' assert. The

The natural and social sciences cannot
merely be integrated in the straightforward form
of a reduction of the latter to the former.
A complex process of reciprocal influence and
mutual enrichment is therefore far at its general base of dialectical materialist monism, which can
not be limited simply to the sphere of nature.

The Soviet philosopher V. F. Aramus, de-
scribing the limits of nature of the old material-
istic world:

The philosophers of the seventeenth
and eighteenth centuries could only im-
plement their anticetic tendencies at the
expense of society + history, which remained
for them beyond the bounds of mat-
terist monism.¹

A consistently monistic, materialist under-
standing both of nature and society lays a favourable
basis for fruitful interaction of the natural and social sciences.

Mathematics has a special role in this inter-
action and also methods of mathematical mod-
elling employing organisational technique and
computers, the role of which is becoming partic-
ularly great today in economics.

The interdisciplinary conceptual apparatus
called a 'system', which has been developing

¹ V. F. Aramus Marx and the Problem of Monism
of the Natural and Social Sciences *Izbrannye sto-
iskoiskie trudy* Vol. I (Mysl, Moscow, 1971), p. 302.

especially rapidly in recent decades on the basis of cybernetics, and which characterises both natural and social objects, is playing a major role in the utilisation of the natural sciences' experience in the social sciences.

The movement of information from natural science into social science is, in general a law of the development of scientific knowledge (Lenin's 'flow to social studies from natural science'). There are not a few examples marking the development of the natural sciences. In *Capital*, for instance, Marx specially stressed that, whereas political economy was originally studied by philosophers, business men and statesmen, medical men (like Petty, Barbon, Mandeville, Quesnay), oriented on man, especially occupied themselves with it 'with the greatest success'.¹

In a famous letter to Engels of 13 February 1866, announcing that the Volume One of *Capital* was ready at the end of December 1865, Marx said that he had found 'the new agricultural chemistry in Germany, especially Leibig and Schönbein, . . . more important (on ground rent) than all the economists put together'.²

There is also a reverse process, of course: new ideas pass from the social sciences into the natural sciences. The concept of static stability, for example, was originally introduced in demographic statistics. A very cardinal idea, that of universal movement and change, was proclaimed earlier in regard to society (1847) than

¹ Karl Marx *Capital*, Vol. I. Translated by S. Moore and E. Avchurina (Progress Publishers, Moscow, 1974), p. 578.

² Karl Marx and Frederick Engels *Selected Correspondence* (International Publishers, New York, 1936), p. 204.

made it the vehicle even of a special sphere (we also find formulations that are close to the Baconian illusion that man, possessing knowledge, can do anything he wishes). But his profound optimism in regard to problems of the inter-relation of society and nature was undoubtedly fruitful.

In the eighteenth century the shrewd Quesnay undertook to work out the first model of a sociobiogeosystem. He argued as follows. The peasantry pay out three billion livres—two as rent to the 'second' class (landowners, the King, and officials) and one billion to the 'third' class (townsmen) but also get back three billion livres—two from the townsmen (for produce and raw materials). The townsmen pay out two billion to the peasantry and also receive two billion (one from the landlords, and one from the peasantry). The 'second' class receives two billions as rent and spends them, paying out one billion to the peasantry and one billion to the townsmen. As we see, Dr. Quesnay's table is balanced money-wise. But product-wise? It will readily be seen that the peasantry, having delivered produce to the tune of three billion livres, received products to the tune of one billion from the townsmen. Where did they get the other two billions of produce? Guided by the principle of conservation, Quesnay concluded that the deficient produce, to the sum of two billions, was produced not by the peasantry but by nature itself.

On that point the great economist was mistaken in rigidly linking society and nature, because we now know that the nobility took not the product of the natural element but the surplus product of the peasants' labour.
" . . . speaks of this in *Capital*. The Physi-

crats' 'naturalistic social science' was quite quickly discarded in historical development by classical political economy, but the interesting conclusion remained from it, which has now acquired special relevance, namely, that there is an organic link between the economic progress and nature. True, the Physiocrats' justified singling out of this link was supplemented by an illusion, to some extent natural in the eighteenth century but whose traditional roots are being extirpated with difficulty even in our day, we have in mind the naïve view that 'we can take from nature gratis' without labour outlays on surplus product. Nature and labour are the two equally necessary conditions of men's being 'As William Petty puts it, labour is its (wealth's) father and the earth its mother'. Rational combination of labour and nature (what we now link with optimisation) has always been a constant concern of reason. We have already noted the inadequate of its direct solution in the spirit of Hegel's 'cunning of reason': man sets a goal and as his power grows it becomes more and more indifferent to him how one natural body acts on another.

Let us cite another of Hegel's theses about the 'cunning of reason':

Reason is just as cunning as it is powerful. Cunning consists in general in mediating activity which, by allowing the objects to act on one another according to their nature and to work on one another, without involving itself directly in the

¹ Cited by Karl Marx in Capital, Vol. I (p. 50) from William Petty, *A Treatise on Taxes and Contributions* (London, 1667), pp. 47, 58.

the more materialism brings only the part
of the materialism.

In emphasis over the grounds of Hegel's idea of
the building interest, we must not omit his meth-
od to be an taken the use of man's realization
of his own self-purification. The experience of
man's life and his home of development teaches us
that it is irrational when posing time, not to
allow for the possibilities of nature itself (which
is most for the idealist Hegel and in isolat-
tion from the idea was a corpse). The activity
of science must not be hyperbolized, reduced to
the voluntarism absurd at the same time it
must not lose its orientation on man (for ideal-
ism according to Lenin always absolutized
only one line of the infinitely complex process
of understanding).

In the nineteenth century Gauthier aptly
said that there was no sense in raising moun-
tains on the grounds that it was difficult for
short-winded people to climb them. While fully
recognising the justice of that idea for the
century of the systematising of knowledge of
nature, we would develop it for twentieth cen-
tury conditions. There is no sense in raising
mountains on the grounds that it can, in prin-
ciple, be done technically though science still
cannot explain to us circumstantially why it
should not be done or what would be the de-
plorable consequences of this global technicized
act for man. The way out, as we have already
said, is not to reject activity but to raise the
level of science in man's activity (quantita-
tively in more information and qualitatively in a
reorientation of information on man).

¹ G. W. F. Hegel *Werke*, Sechster Band. (*Encyclopädie
der philosophischen Wissenschaften in Grundrisse*). Ber-
lin 1830 Verlag von Duncker und Humblot, p. 382.

The development of monism is thus capped by 'homofundamentalism' as an outlook that links a single world with a single treatment of it that makes man's interests its foundation. 'Homofundamentalism' has nothing in common with ontology and logical voluntarism; it casts no doubt on the objectivity of the laws of being. Its task is more modest, to conduct affairs so that the anthropogenic effect on the system of objective laws will have a pro-anthropic direction in future.

Whereas the pro-anthropic direction, however, came about spontaneously earlier in the development of reality, this characteristic of the objective process now depends essentially on anthropogenic, technogenic effects on the biosphere, and so the position has been altered in principle: the spontaneous development of the 'man/nature' relation is now already directed against man.

For people to survive, this relation has to be controlled. A voluntaristic, subjective understanding of activity as spontaneity is fatal for progress. Although there can be no absolute wonder-working, optimising means in the 'man/nature' relation, constant, scientifically based and consciously applied measures could, however, in each concrete case at any given stage, fully ensure a rational compromise between men's wishes and the biosphere's possibilities.

It is extremely necessary for mankind to dissociate itself from the frame of mind that everything in the biosphere gets settled off and by itself. Although such illusions as, say, a nostalgia for an absolute robot that would always optimise everything for us and do everything out us, without our efforts, is inherent in this, the conception of optimisation of the

the density of population led to the destruction of the forests. Furthermore, because dried cow dung was used as the main energy resource, the natural circulation of matter in nature underwent a more and more monstrous distortion. The substances taken by grazing animals from plants were not returned to the soil, because they were burnt. The natural circulation of matter was altered, in Ulrich's expression, to a vicious circle. By virtue of this vast areas of 'paradises' were converted everywhere into a desert. Every year 300 million tonnes of dried cow dung (the energy equivalent of 35 million tonnes of coal) are burnt in the world!

Total negation of technique is, in essence, negation of man as an 'artificial' superstructure on nature (in the sense of not being limited to the laws of nature). Man is a derivative of industry to the same extent as industry is a derivative of man.

The Soviet scholar Solomon Schwartz, bringing out the irreversibility of the social path of man's development wrote, in his paper *Problems of Man's Ecology*:

There is no doubt that industry has a serious effect on the state of the environment. There is no doubt, too, that any cautionary measures (quite necessary) and any degree of improvement of production (closed cycles, etc.) only attenuate the degree of man's effect on nature but do not eliminate the danger of a deterioration of the environment (for even the most competent production removes a vast area of land and water from biological circulation). It seems to me that this position should be self-evident to any person not given to delusions. But it does not

marked, in his time, that mankind 'inevitably sets itself only such tasks as it is able to solve'. From that one may suggest that the very fact of the rise of so-called global problems is evidence that mankind is coming to the point of looking for means to solve them.

These means, of course, above all include measures of a social and political character: the key to resolving them lies along the path of social progress and socialist transformation of human society on a world scale.

At today's stage the decisive condition for successful solution of the problems of global development is undoubtedly practical realisation of detente, and its consolidation and further development in the interests of all nations of the world. At the same time theoretical and methodological analysis of these problems from the angle of a synthesis of knowledge is also important.

What, essentially, are global problems? They are those that concern human life on our planet as a whole, and above all questions of ensuring natural resources for humanity in the future (both renewable—air, fresh water—and non-renewable—primarily energy materials), problems of providing all the inhabitants of the planet with the necessary food; problems of conserving the environment; and problems of reproducing the population and maintaining its health.

Globally formulated problems are thus new to a certain extent not only on the social plane but also methodologically. Their most important

¹ Karl Marx A Contribution to the Critique of Political Economy Translated by S. W. Ryazantskaya (Progress Publishers, Moscow, 1973), p. 21.

change in the forms of nutrition and sources of energy available to man.¹

In our day the problem of rational use of natural resources, which it is inadequate to think of as inexhaustible when analysing the outlook for mankind's development, is becoming particularly pressing.

The need for effective forecasting of the main directions of mankind's development in the immediate future, and for bringing out the most rational means of purposefully affecting these processes, is becoming stronger now, in the 1980s, under the scientific and industrial revolution. Global problems like the establishing of lasting peace and equal international co-operation for all nations, rational use of natural resources and meeting of the demand for energy, elimination of the gravest illnesses and protection of man's habitat, are acquiring an increasingly acute character. In the future these problems will exercise an increasingly perceptible influence on the life of each nation and on the entire system of international relations. The Soviet Union, like other socialist countries, cannot hold aloof from the solution of these problems which affect the interests of all mankind.

Global problems are difficult to study scientifically. Their analysis must take into account the reciprocal connections and relations, and various aspects of reality, apply an interdisciplinary approach with an active interconnection between representatives of the social, natural,

¹ V. I. Vernadsky, *Biogeokhimicheskie ocherki* (Biogeochanical Essays), AN SSSR, Moscow and Leningrad, 1920, p. 55.

ment for example a subsystem of cultural change. From that angle a global model may be considered a means of interpreting and re-appraising the role of traditional social institutions and established cultural standards (a passing from slogan to the thesis about its rational use, rejection of the cult of material needs, etc.)

In both cases it is necessary to bring out the dialectics of the general and the particular, which must find reflection in the model of global development. It is historical materialism, at the sociological theory of Marxism, that makes it possible to tackle this problem adequately, which once more demonstrates its heuristic value.

This point was stressed in Prof Gvishiani's paper on the methodological problems of modelling global development¹.

Effective use of mathematical methods in the investigation of global phenomena of a socio-economic character is complicated by at least two classes of indeterminacy.

The first class is associated with the contradiction between the real system and its simplified description (because of the limitations of the formal apparatus). This circumstance makes it impossible to obtain exact data on the state of the process at any given time from the appropriate models. Furthermore, the more remote the moment of time from the beginning, the greater is the indeterminacy of the state of the global model's behaviour that is fixed.

¹ D. M. Gvishiani. Methodological Problems of Modelling Global Development. *Perspektivy Al'fa-04*, 1974, 2

d facts and circumstances governing decision-making and the implementing of decisions. A host of doctrines for managing the world now occupy the foreground in capitalist social science, while the comprehension of the various social links and ways of affecting the shaping of events is becoming either a subject of special consideration, or is excluded altogether. In that, however paradoxically, the complex mechanism of shaping the requisite, desired direction occupies the centre of capitalist thought, even when it is a matter of the unnecessary and undesirable, because a definite angle on the past, present, and future is formed in both cases that guarantees their being seen only through the prism of capitalist values and goals. In the quest for the spiritual, value foundations of capitalist civilisation, for instance, which capitalist ideologists are trying to defend against break-up and decay, even when it is becoming a matter of the need for a radical alteration of the initial principles of strategic thinking, capitalist conceptions do not break out of the context of the basic conditions governing the existence and functioning of capitalist society. While seeing the need for changes, the authors of these conceptions sometimes, however, do not rise to stating this need for historical changes.

The Club of Rome's reports, drawn up under contemporary capitalism, contain multilevel displays of capitalist consciousness. An important methodological condition for successful application of the new scientific technique of computer modelling of global development is precisely to bring out the elements of capitalist narrowness inherent in the Club's reports.

The leitmotif of its activities, of course, lies

DEFINITION. Limiting itself to a kind of state of **homeostasis**, man is to undertake the necessary **initial** or **active** learning along the road of progressive development. In saying that, we must not omit the also logically significant fact that a picture of mankind on the road of historical progress acceptable to everyone is marked by the continuous initial axiom that homeostasis, as continual as the man's adaptability to the environment is on one side but this axiomatics is proving today (with a full humane setting, apparently for many members of the Club of Rome, sincere in their concern for mankind's future) to be the antipode of the revolutionary posing of the question namely, how to change man's life for the better, i.e. that it is necessary to ² the the circumstances of his being human.

problems of developing countries which they call the Third World. The authors, it is true, are inclined to pass over in silence the genesis of these problems, engendered by centuries of colonial exploitation, and in general do not mention sociological categories like 'exploitation' at all. And they are therefore unable, of course, to employ such terms as, for example, 'emancipation from exploitation' in their description of social development.

Instead of the future commonwealth of peoples emancipated from exploitation, therefore, they see a certain time out of memory equatorial boundary generating a sociocultural 'North-South' model.¹ The relations between the sub-models in this system are interpreted in a stale philanthropic form—the 'North' voluntarily makes 'gifts' to the 'South'. The motive for this giving is often, moreover, according to the Club of Rome authors, a frankly selfish consideration: the gift has to be sent so that the despairing 'South' (not having received much) will not go to extremes. Humanistic slogans sometimes prove a simple cover for a selfish desire to buy oneself off, just as the rich often give crumbs to the poor for their own consolation, the poor, of course, not only do not cease to be poor by this act of giving but on the contrary become deeper rooted in this social quality, feeling their poverty even more. The reverse of this philanthropism also proves (historically) to be neocolonialism.

It is quite understandable, however, that the heart of the matter is not the moral and ethical side of these acts. By absolutising gifts from

¹ 'North' in this posing of the problem embraces the industrially developed countries, and 'South' developing countries.

be 'North' to the 'South', the report writers raise it very nearly to the rank of a social law, thereby falling into voluntarism, because they thereby conceal the really objective law of the development of the capitalist world in the epoch of imperialism, and particularly the law of the unequal economic and political development of capitalist countries in this era, discovered by Lenin. This law has by no means ceased to operate—it is no accident that Japan, still 'savage' a century ago, has been transformed in a couple of decades into the second country in the capitalist world.

It must also not be forgotten, however, that the question of aid has a class character in the politics of the mutual assistance of states. Analysis of this aid cannot be separated from consideration of what class is helping what class, and for what historical perspectives. That posing of the issue is particularly essential in relation to models for 'reshaping the international order'.

When analysing Tinbergen's report, it is important not to lose sight of the elements of utopian philanthropism inherent in it for, in proposing the rendering of aid to developing countries by developed countries, the report quite glosses over the question of the forms of organisation of rational use of this aid. Without such organisation it is quite probable, by this 'scenario', that the lion's share of the aid will go not to the development of developing nations emancipated from colonialism but to the further enrichment of feudal rulers and comprador capitalists.

It might be expedient to discuss at a meeting with members of the Club of Rome the question of whether their reports analyse the extent of

— common ground for dealing with global problems might lie through international understanding between sovereign states in conditions of extended state interests.

Attempts to forecast the dynamics of some factors in social affairs (population growth, use of energy, dynamics of production etc.) have long been made. The contribution of the Club of Rome has been to steer these factors (blocks) in their reciprocal relation in the reciprocal conditioning of social and cultural parameters on the basis of a variable computer modelling of different situations that indicates the dynamics of the change in all the other selected parameters with a given trajectory of the initial one (scenarioization of global problems). The concrete applications, in the projects however of this productive methodological orientation on quantifying certain essential mechanisms of the social form of motion of matter suffer from serious omissions

* a general methodological character

As we have already noted the Club of Rome's task lies to depict the systems moment

A truly consistent version of systems analysis cannot avoid being based on the most consistent theory of development, i.e. on materialist dialectics. The dialectical materialist version of the systems approach, however, has yet to be developed in many of its essential moments, relying, of course, both on the positive and the negative experience of the Club of Rome's research.

While we must stress that a common methodological feature of the Club of Rome's schemes is their empiricism and lack of a consistent, integral scientific theory, dialectically interpreting the social and scientific data. In that vital fact the anti-systems component of the methodology of capitalist conceptions of modelling global development finds reflection (although, of course, individual applied systems methods are given constructive development in it, above all the systems dynamics referred to above, and the theory of hierarchical structures). Both the initial axiomatics and the final conclusions of the Club of Rome are based on conceptions of pluralism that obscure an integral systems vision of civilisation in its progressive development.

Pluralistic stagnation is thus distinguished as a form of development interpreted as 'survival', as a getting rid of the hazards of the moment that will be succeeded tomorrow by ever more terrible dangers. The radical change associated with the revolutionary alternative is masked by pluralistic apologetics. Real systems modelling of global development is based on affirming for the objective integrity and general humanity of the socialist path. That conclusion includes an ecological application of materialist dialectics, which is, according to Lenin, the revolutionary soul of Marxism.

stuck in the context of an interpretation of development as a quantitative, evolutionary process without qualitative leaps occurring in the course of the struggle of opposites. What is this conclusion based on? Above all on the fundamental thesis that social revolution is a transition on the basis of class struggle to a new, more highly organised socio-economic formation.

The new quality in the social sphere takes shape in the course of the struggle of progressive forces against reactionary ones. All these real phenomena, however, remain a *terra incognita* for the members of the Club of Rome. For that reason, no matter how the details and subtleties of computer programs and models are refined, the internal imperfection of the ideas of development in its reports cannot help having its effect. Even such a matured process today as the transition of more and more new countries and nations to a socialist-oriented road is not even mentioned in the Club's models. Models of global development are generated without real social development and without the real social facts.

The ignoring of real global trends toward social transformations of the relations of production in the modern world foreordains the presence of real, substantial elements of utopianism in the Club of Rome's models. Their main expression of utopianism is linked with lack of understanding of the determinant progressive role of the international working class as the subject of history. To talk in our age of improving the world, while ignoring the International working class and its main gain, the system of socialist countries, means at least to fall into the worst form of utopianism.

What we have said does not, certainly, entirely deny the positive significance of the work

ist Leninist theory, which unites a scientific understanding of nature and a scientific understanding of society. In capitalist society an irreconcilable dilemma: a scientific understanding of nature and a capitalist sociological theory, unscientific on the whole, is resolved in this very fashion in the form of the theory of convergence. An echo of it is often heard in the Club of Rome's reports, which frequently aspire to a suprasocial position.

Because the mathematician addresses himself to ideologically significant problems of global development, these problems do not cease to be ideological. In order to provide an integrative, ideological block of models, an ideology is needed that has become scientific, viz., the scientific ideology of Marxism-Leninism. As Lenin remarked in *Materialism and Empirio-Criticism*, however, 'these people's whole environment estranges them from Marx and Engels'.¹ Because of their estrangement from Marxist methodology the reports of the Club of Rome acquire a blurred character on the ideological plane.

That happens not only because of the conditionalities and even the often complete absence in general of initial definitions, and a shifting of ground, but also because of the text is saturated with such elements as reproduction of the stereotypes of the consciousness of certain strata of the Western intelligentsia, and reliance of faith, intuition, etc. As far as one can judge, the authors do not count on their recommendations being adopted as a practical action programme by governments.

¹ V. I. Lenin 'Materialism and Empirio-Criticism', *Selected Works*, Vol. 11 (Progress Publishers, Moscow 1958), p. 263.



to life to predict the direction of progress, and
of evolution of nature.

The problem of human and social progress and
the fact it cannot be interpreted simply as a
process of simple quantitative growth, because
by this process it is a qualitative development
of society. The direction of development of a system is
linked with the change in its quality.

This process is expressed in organic activity
in new ecological formations in change of
climate, the formation of states and so on. It
is more often it is expressed in qualitative char-
ges of the environment (the rise of new species
of plants and animals). Qualitative character and
direction are expressed in social development of
the succession of socio-economic formations,
which includes social progress and progressive
movement from communal inter relations to
relations within the context of a socialist or com-
munist system.

Conceptions of a catastrophic plane, that is to
development as movement towards ecological ca-
tastrophe are common in capitalist conception^s
as a counterweight to this optimistic interpreta-
tion of global problems. The authors of such per-
sonistic, almost theological views often base them-
selves on metaphysical notions in the special
sciences. The idea of the directional character of
development, interpreted as a tendency to cata-
strophe, has been displayed in a number of spheres
of science. Some biologists tried to represent
the evolution of animals as a process of the grad-
ual dissipation of certain reserves of 'vital ener-
gy'; a thesis of the 'finale of evolution', 'the de-
generation of phylogenetic lines', etc., has been
put forward.

When man's impact on the biosphere was in-
tensified in the course of the scientific and indus-



relation of class and political forces both on a planet-wide scale and in separate regions and countries.

Since the ecological problem, however, belongs to a special class of systemic problems for which both the polyfactorial character and multi-level connections of present control operations and their future, very remote consequences are often indicative, it is expedient to employ the techniques of computer modelling, as a technical instrument based on the achievements of present-day scientific and technical advances to analyse it.

Grisbiani has stressed, in characterising global systems problems, that

the specific nature of these problems lies in their highly complex character, truly global scale, and dependence on a great many heterogeneous factors—natural, technical, economic, social, and cultural. That means that problems of this kind must be analysed in an overall way, system-wise, allowing for reciprocal connections and relations, through the broad application of an inter-discipline approach and the joint work of social scientists, economists, and applied scientists... Such a posing of the question presupposes active utilisation of new research techniques. We would draw special attention to the possibility of employing such a scientific approach as global modelling using formal mathematical techniques.¹

Quite understandably man's role in dealing with human problems remains decisive, and the functioning of the global model is oriented on a

¹ D. M. Grisbiani. *Art. cit.*, pp. 14-15.

THE INTEGRATION OF ACTIVITY

(In lieu of a Conclusion)

Our exposition is ending. And it seems to us that its concluding section can hardly be rationally built on a compressed repetition of what has been surveyed in the foregoing. It would be better, in conclusion, to try and lay a bridge to subsequent research into today's problems of monism and the forms of the unity of society and nature. We have laid stress on analysing ecological monism as an element of the methodology of modern scientific knowledge. The axiologic (i.e. value) aspects of the interaction of society and nature, however, are no less important. The monistic principle of dialectical materialism can itself, moreover, only be based on a unity of methodology and axiology realised in an axiologised methodology. This problem is to some extent becoming a sign of the times, and its analysis is acquiring mounting interest.¹ The unity

¹ O. Drobniitsky, *Mir ozhivoshchikh predmetov* (The World of Animated Objects), Politizdat, Moscow, 1972; I. B. Novik, The Unity of Methodology and Axiology as an Expression of the Synthesis of Knowledge, in: V. A. Ambartsumyan et al. (Eds.), *Sistemnye issledovaniya nauchnogo znaniya* (Nauka, Moscow and Leningrad, 1972); T. S. Tiselius and S. Nilsson (Eds.), *The Problem of the Unity of the World of Facts. Proceedings of the International Conference*, Stockholm, 15-20 August, 1970.

of methodology and axiology is evidence that the synthesis of scientific knowledge should, on being introduced into practice, bring about an integration of all forms of human activity. Synthesis of the sciences is not an end in itself but a theoretical precondition of the integration and harmonization of activity that would allow subjective arbitrariness to be overcome, i.e. voluntarism in regard to the environment.

In its scientific resonance the problem of the interaction of man and nature emerges as the practical aspect of philosophy's basic question, that of the relation of subject and object. This is one of the perennial philosophic themes that get a different ring and are comprehended differently according to the historical epoch. In today's scientific and industrial revolution the problem has become extremely topical, and has acquired a menacing ring, that is linked with disturbance of already the dynamic equilibrium between nature and society on a regional scale, and by a number of parameters on a global scale as well. This position is being exacerbated by the retention in part of the world of private enterprise.

Overcoming of the undesirable trends in the present-day ecological situation calls for the development and adoption of a new ecological strategy, to the substantiation of which the Marxist-Leninist conception of the material unity of the world and of the unity of subject and object, consciousness and being, has a leading part to play. The present stage in the ecological contradiction between society and nature has sharply posed the question of what can the acting subject do and what are the objective bans governing that activity. A principled answer to that question is provided by materialist dialectics.

which, by its very nature, is directed against a voluntaristic rupture between the conscious stirrings of the subject and the trends of development of objective reality.

So far, together with growth of various kinds of opportunity for man's activity to alter the biosphere, the negative aspects of technogenic affects on the environment have also been growing rapidly, which manifests the results of ecological voluntarism.

The essence of the ecological variant of voluntarism is an absolutising of technical power without considering the biosphere's evolutionary possibilities. Consistent disclosure of its unsoundness is an essential methodological precondition for optimising the biosphere.

Ecological voluntarism has to be overcome on three levels: (a) on the highest, social level (eliminating class antagonism, and a one-sided relation of people to one another and to nature); (b) on the theoretical level (perfecting of knowledge of the fundamental laws of the functioning and development of the biosphere); and (c) on the production, practical level, because practice is the historical process of man's transformation of nature and the embodiment of man's unity with nature.

Over a long historical period, however, the unity of man and nature has been distorted by the structure of an antagonistic society's relations of production. Over the whole duration of antagonistic socio-economic formations, with an opposition between mental and physical labour, the status of Reason (interpreted on the plane of voluntaristic will) has been allotted to the exploiting classes, and correspondingly the status of inert, dead matter to the exploited classes. And because the ruling class has 'the vote' in history,

the whole history of world culture is permeated through and through with a voluntaristic spirit of dominance and progressing superiority over the environment. Before the stage of the capitalist mode of production was reached, however, with its own class form, man's opportunities for a voluntaristic attitude to his habitat and development were limited primarily by the existing technological potential of production.

Bacon's principle of the correspondence of man's possibilities and knowledge belongs to that period: you can do as much as you know. From which also follows the thesis of voluntaristic domination over nature. Thus, we read in *The New Atlantis*:

The end of our foundation is the knowledge of causes, and secret motions of things, and the enlarging of the bounds of human empire, to the effecting of all things possible (My italics — I N) ¹

With developing society's attainment of certain technological heights voluntaristically interpreted Reason is transformed from an objective regulator of production to a productive force in the image of science, and moreover a productive force of that mode of production in which 'production appears as the aim of mankind and wealth as the aim of production',² and in which the producer of material blessings is only a means, a tool.³

¹ Francis Bacon *Essays Civil and Moral and the New Atlantis*, P F Collier & Son, New York, 1909, Vol 3, p 181.

² Karl Marx *Grundrisse* Translated by Martin Nicolaus (Penguin Books, Harmondsworth 1973), p 498.

³ Karl Marx MSS of Capital Book 1 Chapter Six 'Results of the Direct Process of Production' cited from K. Marx and F. Engels *Sokrashcheniya 2nd ed.* Vol 40 (Politizdat, Moscow, 1974), p 44.

There is profound sense in the analogy between the historical dynamics of the position of nature in the system of inter-relations of society and nature because both man and nature are means of production.

Under capitalism the expansion of production for the sake of profit has reached its apogee: its sphere has involved the human body and human consciousness and a considerable part of the environment. Production's all-permissiveness in relation to the producers ultimately converts the real subject the producer of material goods, into the object they are also related to nature as to the object from whose conquest it is possible to obtain benefits and profits.

Investigation of the causes of ecological voluntarism rests in the final analysis, on the dialectic of subject-object relations, which has to be treated as the model the conceptual framework, for understanding and overcoming it that is at the same time the theoretical justification of the whole business of optimising the inter-relations of man, society and nature.

Mankind functions in production activity primarily as a natural force, but it is also in just that activity that it sloughs off its directly natural character. In production activity mankind develops its own freedom as a result of activity taken in as a unity and of harmonisation of all its differentiated subdivisions to in its integrity. In antagonistic socio-economic formations "humanned" nature is opposed to man as private property engendering a view of it as something external, and passive and conditioning an approach to society as amoral and unlimited in the possibilities of its practical effect on nature and man (and hence ecological voluntarism).

A voluntarism of an ecological character is a

manifestation of production for the sake of profit in all spheres of human vital activity and in all 'humanised' nature. Under capitalism it is not so much a matter of the congruity of the organisation of production with organisation of the biosphere as a question of subordination of the latter to the former, which also leads precisely to the ever mounting danger of an ecological crisis.

Within the social antagonism the needs of production are the main factor in the development of science and technique. During the whole of this period technique has existed as an immense weapon for exploiting man and nature. That relation both to man and to nature must now be radically reconsidered. The very progress of practice and theory calls for a generalising of the scientific approach going beyond the limits of what has traditionally been considered science, for example encroaching on the field of morality (just as morality is intruding more and more insistently into the very texture of scientific knowledge).

The increasing unity of the traditional forms of social consciousness is itself evidence of the material unity of the world and reflects the inner unity of human activity.

The double triad of being and knowledge, viz. (a) the microworld-macroworld-megaworld, and (b) the inanimate animate social, is not a counter-argument to the conception of monism but, on the contrary, concretises it. For the whole sphere of being is unsubstantial, that is to say, has matter in motion, and its attributes, as its sole foundation.

All these three forms of the real process are genetically connected, despite their specific character. Their relative separation from one another is for practical purposes a certain idealisation of reality. This idealisation has now become extreme.

ly strong (crude), and it is now necessary to take the moment of the unity of the world into account in human activity because the breaking up of the sphere of being provided the ontological basis for the breaking up of the various areas of human activity.

Because of the excessive fragmentation of activity, its results are more and more beginning to clash with one another, creating conflicts. The division of labour and specialisation of activity have always undoubtedly been an instrument for making activity more effective. And we must not reject this instrument in the age of the scientific and industrial revolution, but its application should not become 'excessive', for partial forms of activity, while effective within their own narrow limits, sometimes dovetail badly, leading to an artificially lowered total effect. It is necessary to compensate the division of activity by a certain integral approach to managing it, so that a monistic reconstruction of activity is on the agenda, i.e. the development of ways and means of integrating them more intimately on the basis of an ever fuller and more distinct disclosure of its universal, single basis.

The integration of activity is not, of course, a once and for all act but a complex dialectical process passing through several stages and realised in several interconnected forms. In the first place we must note here the growing role of the aggregating of activity in all fields of the building of communism. While breaking through in one sector or another, be it ever so important, we can no longer afford any drawn-out lag in any of the others.

The society of developed socialism founded on a powerful material and technical basis has broad possibilities for comprehensive development of

all its spheres—economic and political, spiritual, family, and domestic. The interconnection and interdependence of these spheres and aspects of modern society tend to be considered by science and practice.

Soviet society dispenses of a powerful scientific potential in order to deal with these problems. The science of developed socialism is connected by thousands of threads with all forms and types of Soviet man's activity. It is a single organism whose effectiveness will increase ever stronger as the interaction of the social and natural sciences develops.

On the basis of the progressing development of the natural and social sciences, the scientific standard of the management of all sectors of planned society's activity will be raised. The various forms of activity occurring in time and space will thereby be co-ordinated more successfully, and co-ordination dynamics will be steadily improved as the theoretical basis of the technical aspect of the scientific conception of management.

In this co-ordination dynamics the relativistic, four-dimensional aspect of the co-ordination links (i.e. allowing for the unity of space and time) is very important. Co-ordination dynamics of a relativistic type (four-dimensional) presupposes not only synchronous dovetailing of the types and forms of activity in space but also their integration in time. In other words it presupposes its own kind of calculus of the consequences of the nature transforming activity of technique-armed man. In present day conditions man's activity can achieve its highest synthesis, can most fully compensate the adverse consequences of unrestrained growth of the division of labour, not through complete repetition of spe-

liberation, but through understanding perfecting of integral coordination over a long period, even though preserving its specific nature as form of human activity but subordinated to the major principle i.e. to the good of man. The subjects of the social system based on collective ownership in realising this major synthetic coordination of activity are beyond doubt, but enormous efforts are required so as use them to the maximum.

Final Statement has said:

We do not want to underestimate the forces of those with whom we have to compete in the scientific and technological sphere. Here the struggle will be a long and difficult one. And we are fully resolved to wage it earnest so as to demonstrate the superiority of socialism in this sphere as well. This meets not only the interests of communist construction in our country but also those of world socialism and the entire revolutionary and liberation movement.¹

The line of this struggle is that of measures for the rational utilisation of socialist society's natural resources and environmental protection.

¹ *International Meeting of Communist and Workers' Parties, Moscow, 1969* (Peace and Socialist Publishers, Prague, 1969), p. 167.

APPENDIX

{Basic Terms}

Ecological problem—the problem of the inter relation of society and nature. At the present stage of mankind's historical development it is complicated by technical development unco-ordinated with the biosphere's possibilities, i.e. the possibilities of the envelope of the Earth inhabited by living matter. The theory of the biosphere was developed by the Soviet scientist V. I. Vernadsky (1863-1945).

Approaches to dealing with the ecological problem differ depending on the character of social relations and the structure of the socio-economic system.

Optimisation of the inter relation of society and nature is the path and means of restoring dynamic equilibrium between them in conditions of continuing scientific and industrial development. Realisation of optimisation in the ecological field presupposes a compromise between technical systems and the biosphere's limited possibilities. In this book the term optimisation is understood in the general sense as the process of defining a maximum relation (not necessarily expressible mathematically) between society and nature in the given concrete historical conditions. Man himself functions as the universal criterion of optimisation so understood in a generalised sense.

Moscow in this book ~ approach to solution of the ecological problem signifies the application and generalisation of philosophical monism as a theory that recognises only one substance underlying the world (in the text, materialist monism is expounded which takes matter as the foundation of all phenomena and of the phenomena of reality).

Systems analysis and systems modelling of the processes of global development are a modern technical instrument for studying possible trends of the future moulding of socio-economic and socio-ecological phenomena on the scale of individual countries, regions and the planet as a whole. Systems analysis starts from the idea of the studied objects as systems, i.e. as sets of interconnected elements and their multilevel relations. It includes both mathematically treated, formalised procedures and non-formal methods of the qualitative description of poorly structured problems.

Systems modelling of the processes of global development is based on the use of computers processing an enormous mass of initial data. The mathematical structure of the model itself depends on the initial conceptual principles of modelling.

Ecological technological resolution This is the answer of the qualitative transformation of human activity (above all in the field of technique) in order to balance mounting production and the biosphere's limited possibilities. The dialectical approach to global modelling is based on the thesis of the fundamental compatibility of technique and the biosphere, but in order to realise this possibility a substantial transformation of technological processes (among a complex variety of measures) is also needed, through means obtained by ending the arms race.

Integration of the sciences This is the objective trend (independent of men's consciousness) of a coming together of previously very widely separated scientific disciplines and the establishment of forms of interaction between them. The conception of the integration of knowledge takes into account both an exchange of information from the various branches of science and a general theoretical synthesis of the sciences in which, in the author's view, the leading role of physics in the sciences of nature will be maintained and developed

Axiological approach This is an approach to the development of technique and science from the value orientation that predominates in the given historical type of social relations. The humanist structure of the value orientation under socialism is described, in which the whole process of scientific and technical, socio-economic, and cultural development is subordinated, as its highest goal, to the formation of an all round, integrated man.

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